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FIRST QUARTER 1992
AMBIENT AIR MONITORING REPORT
LIVINGSTON RAIL YARD

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ENVIROCON, INC.

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FIRST QUARTER 1992
AMBIENT AIR MONITORING REPORT
LIVINGSTON RAIL YARD

Submitted to:

Montana Department of Health
and Environmental Sciences
Cogswell Building
Helena, Montana 59620

Submitted by:

Burlington Northern Railroad Co.
9401 Indian Creek Parkway
Overland Park, KS 66201

Prepared by:

Envirocon, Inc.
P.O. Box 8243
Missoula, Montana 59807

Submittal date:

May 19, 1992

ENVIROCON, INC.

1.0 INTRODUCTION

This document presents the results of Burlington Northern Railroad's (BNRR's) ambient air monitoring investigations conducted by Envirocon, Inc. during the first quarter of 1992 for the Livingston Rail Yard project, in Livingston, Montana. The purpose of ambient air monitoring is to assess the impact of existing site contamination and remedial activities on ambient air quality. Ambient air monitoring data collection began on November 10, 1990. This quarterly report represents the period between January 1 and March 31, 1992. Measured parameters, defined by Section 14.4 of the Interim Remedial Measures Work Plan (IRMWP) (Envirocon, 1989), originally included PM10, TSP, metals, PNAs, and meteorology. In June of 1991, with MDHES' approval, the measured parameters were reduced to include PM10 and meteorology. The TSP, metal, and PAH results were discussed in the First Quarterly Ambient Air Monitoring Report (Envirocon, 1990). All results through March 31, 1991 are presented in the Draft Remedial Investigation Report (Envirocon, 1991).

The design and operation of the ambient air monitoring program are in accordance with the Interim Remedial Measures Work Plan (IRMWP), as amended. Envirocon is responsible for the equipment's daily operations. Bison Engineering, Inc. provides assistance by conducting audits, performing the laboratory work, and assisting with quarterly-report data preparation.

2.0 NETWORK CONFIGURATION

2.1 Monitoring Locations - General

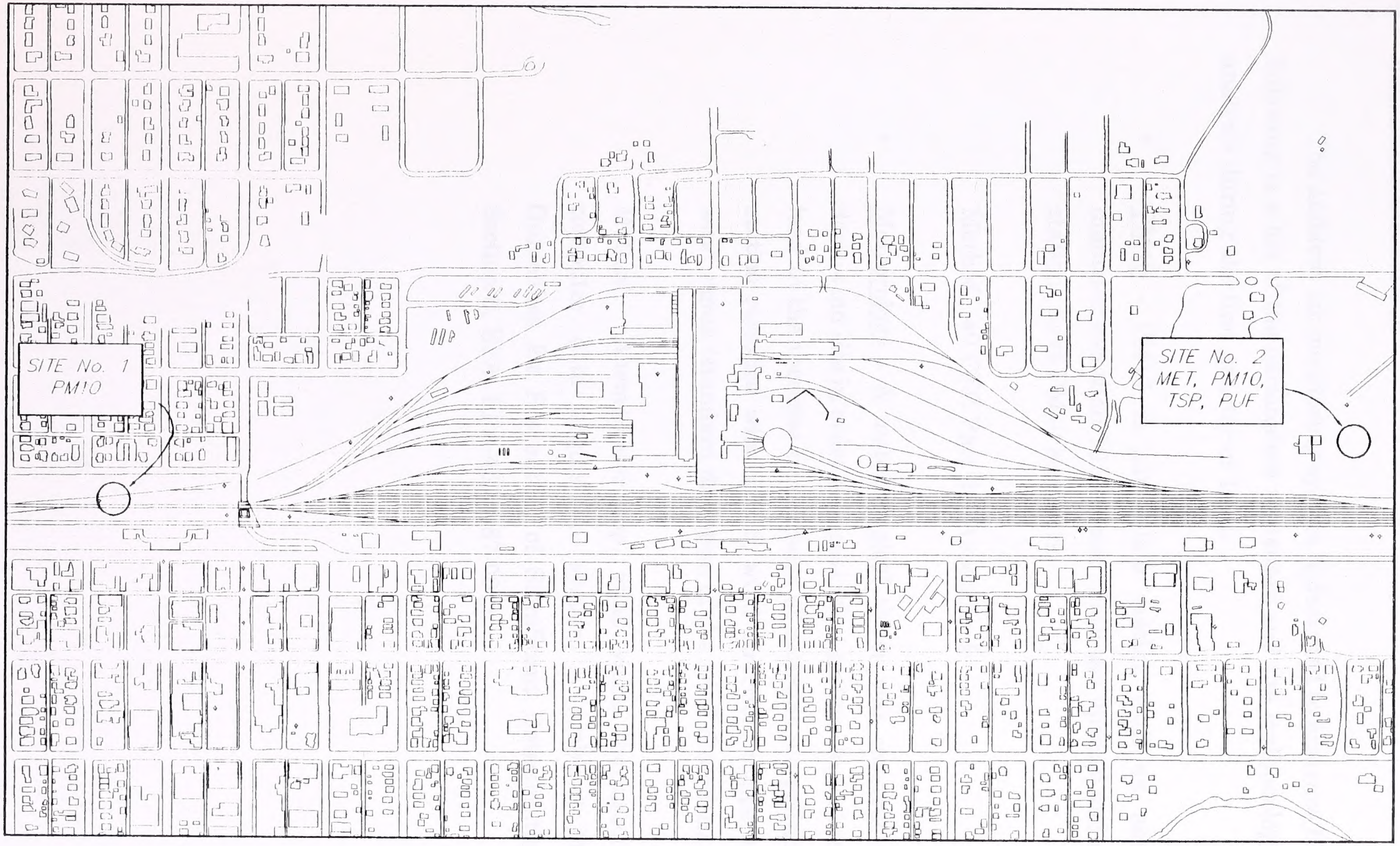
The ambient air monitoring network consists of an upwind station and a downwind station. Each station contains a PM10 air monitoring instrument. The downwind station also contains meteorological equipment.

The upwind station measures ambient air quality upwind of all remedial activities. The downwind station is located to measure worst-case ambient air impacted by remediation activities. In addition, ambient air at the downwind station is impacted by current rail yard operations. Figure 1.0 shows the locations of both stations. The coordinate locations of these sites are shown on Table 1.0.

Table 1.0
Ambient Monitoring Locations

Station	UTM East	UTM North	North Latitude	West Longitude
Upwind	334050	5056410	45^{0} 38’ 36"	110^{0} 33’ 26"
Downwind	335360	5057520	45^{0} 39’ 13"	110^{0} 32’ 47"

UTM ZONE = 12



BURLINGTON NORTHERN

ENVIROCON, INC.

ADDENDUM 14-4
AMBIENT AIR MONITORING

UPWIND & DOWNWIND AMBIENT
AIR MONITORING LOCATIONS

140101

5/31/91

FIGURE 1.0

AutoCAD FILE: BN1.DWG

2.2 Monitoring Parameters

The ambient air monitoring system is designed to measure PM10. The following is a list of the parameters measured and the methodology used for analysis during the first quarter of 1992:

- PM10 - PM10 is particulate matter with an aerodynamic diameter less than 10 microns. Both the upwind and downwind stations have PM10 samplers.

  Method: 40 CFR Part 50, Appendix J

- Meteorology - A meteorological tower was constructed at the downwind site in order to assess what meteorological events may lead to the increase or decrease of ambient air pollutants. The station recorded wind speed, wind direction, temperature, and wind sigma (standard deviation of the wind direction).

  Method: Anemometer cup, wind vane, thermocouple, and computer data acquisition system. (Ambient Monitoring Guidelines for Prevention of Significant Deterioration [PSD], Section 6, EPA, EPA-450/4-87-007).

2.3 Monitoring Frequency

The monitoring frequency for each parameter is shown on Table 2.0.

Table 2.0

Ambient Monitoring Frequency

PM10	One-day-in-six, 24-hour sample Upwind and downwind stations
Meteorology	Continuous sampling Hourly data analysis Downwind station only

3.0 DATA SUMMARY

3.1 PM10

Twelve PM10 samples were collected at the upwind station and 15 PM10 samples were collected at the downwind station between January 1 and March 31, 1992. PM10 data recovery completeness for this period was 90%. Three consecutive PM10 samples were lost at the upwind station. Montana Rail Link was rebuilding the weigh station and interrupted the power that is shared by Montana Rail Link and the PM10 sampler.

The mean PM10 values for this period were 17 ug/m^3 at the upwind station and 16 ug/m^3 at the downwind station. The peak PM10 reporting values for the upwind and downwind stations were 29 and 34 ug/m^3, respectively. These values are compared against the Montana ambient air quality standards on Table 3.0.

Table 3.0 - PM10 Results vs Ambient Standards

	Standard	Upwind Station	Downwind Station
Arithmetic Mean	50*	17	16
Peak	150**	29	34

Units: ug/m^3
* Annual mean
** Not to be exceeded more than once per year.

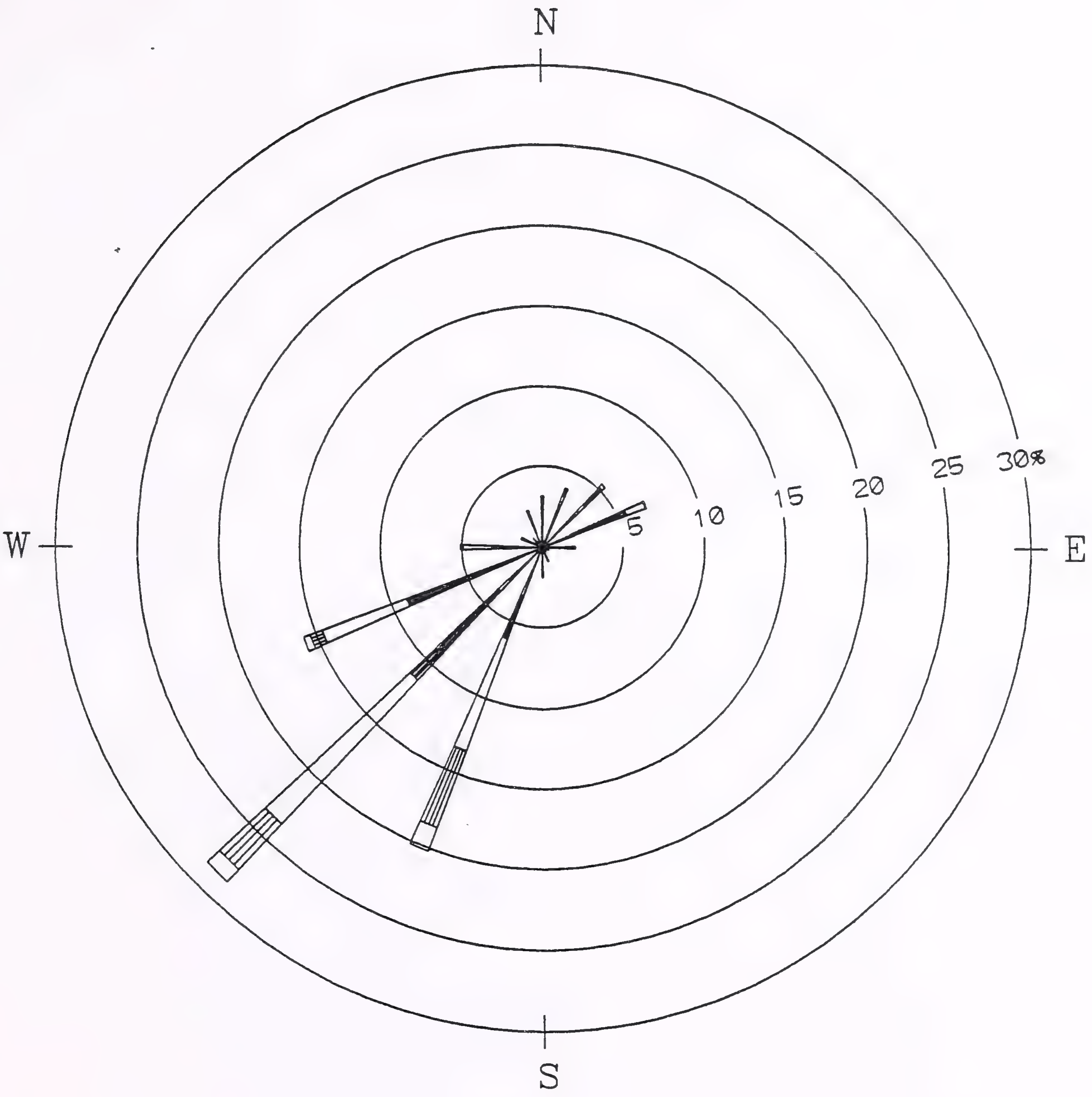
Complete PM10 data and summary statistics are provided in Appendix A. The statistics include monthly means, yearly means to-date, geometric means, and standard deviations. Appendix B contains the results of calibrations and audits.

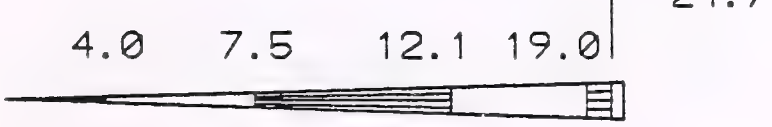
3.2 Meteorology

The meteorological station at the downwind site measures wind speed, wind direction, and temperature. Overall data recovery for the meteorological system was excellent during the first quarter of 1992, with 100% completeness.

Between January 1 and March 31, 1992, the average wind speed was 12.0 miles per hour, the resultant wind direction was 224.9 degrees, and the percentage of calm hours was 0.0 percent. The maximum temperature during this period was 64^0 F, the minimum temperature was 1^0 F, and the average temperature was 38^0 F.

Appendix A contains a complete listing of the meteorological information for wind speed, wind direction, wind sigma, and temperature. Appendix A also contains monthly and seasonal (to-date) wind frequency distribution data. Wind roses are shown on Figures 2.0 through 5.0.





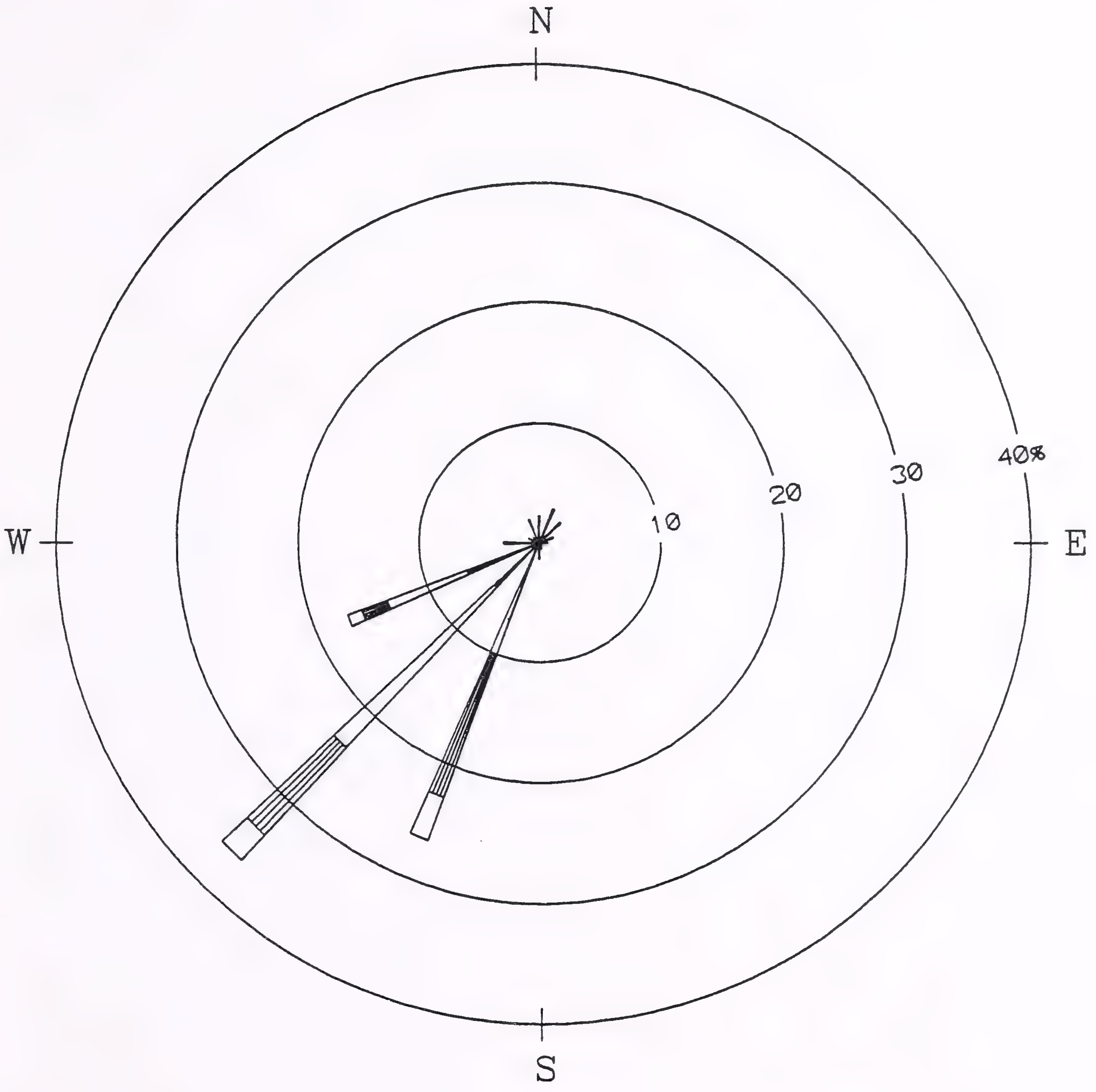
Wind Speed Class Boundaries
(Miles/Hour)

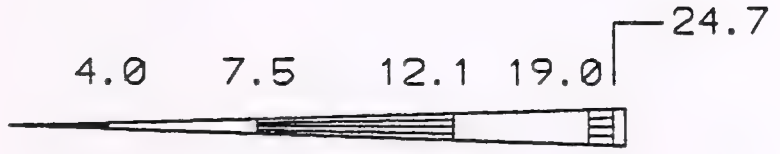
NOTES:
Diagram of the Frequency of
Occurrence for each Wind Direction.
Wind Direction is the Direction
From Which the Wind is Blowing.

WINDROSE

Figure 2.0
Envirocon Livingston
PERIOD: 1st Qrt 1992

Bison
Engineering





Wind Speed Class Boundaries
(Miles/Hour)

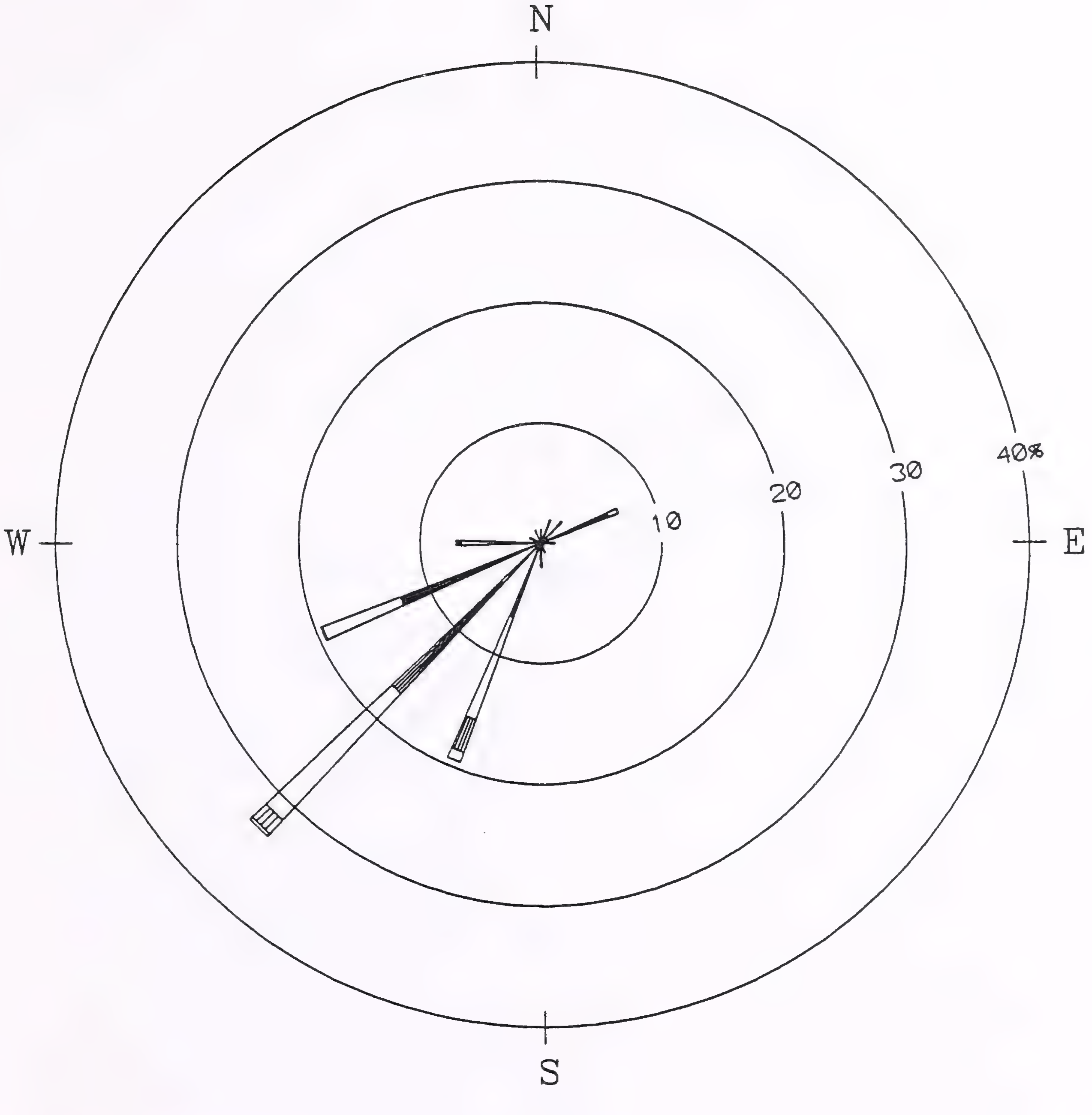
NOTES:
Diagram of the Frequency of
Occurrence for each Wind Direction.
Wind Direction is the Direction
From Which the Wind is Blowing.

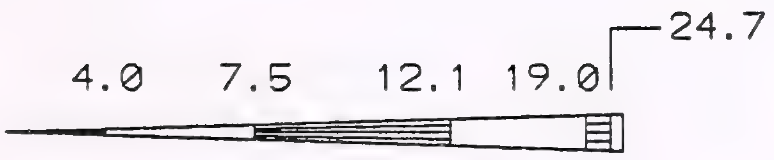
WINDROSE

Figure 3.0

Envirocon Livingston
PERIOD: January 1992

Bison
Engineering





Wind Speed Class Boundaries
(Miles/Hour)

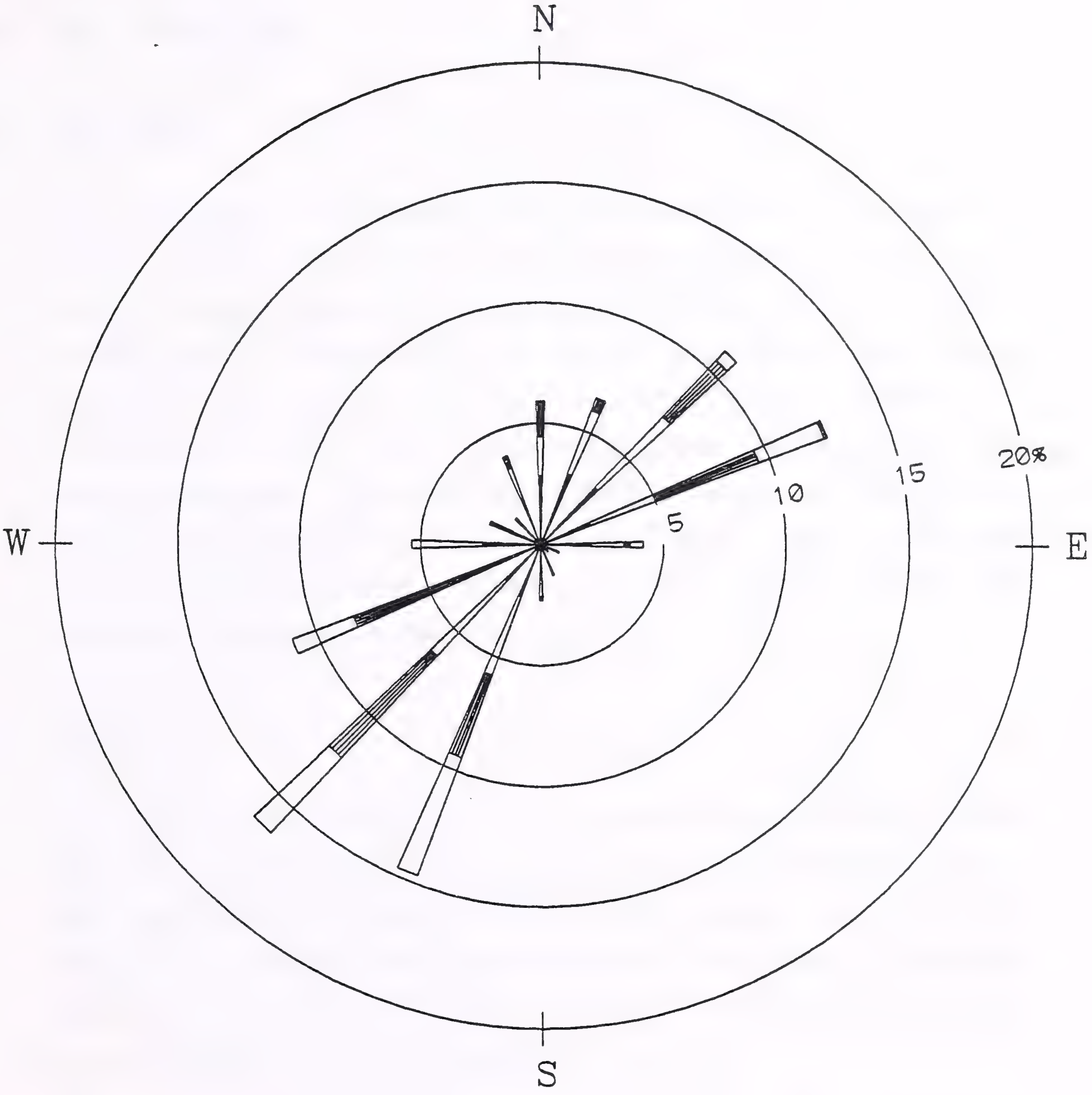
NOTES:
Diagram of the Frequency of Occurrence for each Wind Direction. Wind Direction is the Direction From Which the Wind is Blowing.

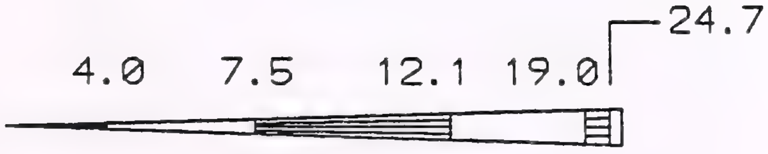
WINDROSE

Figure 4.0

Envirocon Livingston
PERIOD: February 1992

Bison
Engineering





Wind Speed Class Boundaries
(Miles/Hour)

NOTES:

Diagram of the Frequency of Occurrence for each Wind Direction. Wind Direction is the Direction From Which the Wind is Blowing.

WINDROSE

Figure 5.0
Envirocon Livingston
PERIOD: March 1992

Bison
Engineering

4.0 DATA ANALYSIS

4.1 Introduction

The purpose of the ambient air monitoring network is to assess the impacts of existing site contamination and remedial activities on ambient air quality. However, the ambient air monitoring network can not distinguish between sources associated with previous site contamination and sources associated with current industrial operations. The first step of assessment is to measure parameters which could be reasonably expected to enter the ambient atmosphere. The second step of the assessment is to compare these results with previously established ambient air quality standards. The final step of assessment is to compare the results with background results. The following is a discussion of PM10 results.

4.2 PM10

Section 3.0 of this report provided a comparison between the collected PM10 values and the Montana and national ambient air quality standards. The results indicate values well below these standards. All information collected to-date indicates that the standards will not be exceeded. Envirocon compared the upwind and downwind PM10 data, and the results of this investigation are provided on Table 4.0.

Table 4.0

Upwind/Downwind PM10 Comparison

SAMPLE DATE	UPWIND	DOWNWIND	DIFFERENCE
1/4/92	10	10	0
1/13/92	N/A	16	
1/19/92	10	7	3
1/25/92	12	9	3
1/31/92	14	12	2
2/6/92	25	31	-6
2/12/92	14	14	0
2/18/92	10	9	1
2/24/92	N/A	14	
3/1/92	N/A	14	
3/7/92	14	11	3
3/13/92	29	24	5
3/19/92	13	13	0
3/25/92	26	34	-8
3/31/92	21	18	3

Units: Micrograms/cubic meter

Two statistical tests were applied to the data. The tests (paired difference and unpaired t-tests) were designed to assess whether or not there is enough evidence to reject the null hypothesis that the two means are the same. Statistics used to calculate t-test values are summarized on Table 5.0.

Table 5.0

Summary Statistics

UPWIND	Mean: Std Dev: No. of Samples:	16.50 6.56 12
DOWNWIND	Mean: Std Dev: No. of Samples:	15.73 7.72 15
DIFFERENCE	Mean: Std Dev: No. of Samples:	0.5 3.69 12

Comparison of Upwind and Downwind Means

Paired Difference t-test:

t = Mean/(S/(n)^.5) where S = std. dev.

t = 0.47

Critical t (95%) = +/- 2.20

Unpaired t-test:

$t = (\text{mean1} - \text{mean2})/(S^*(1/n_1+1/n_2)^\wedge.5)$ where S = pooled std. dev.

t = 0.27

Critical t (95%) = +/- 2.06

The t value for both the paired difference and the unpaired t-test falls within its respective 95-percent two-tailed confidence interval (as defined by the critical t value). It is concluded that not enough evidence is present to reject the null hypothesis. Therefore, it appears that there is no difference in the mean PM10 values between the upwind and downwind monitoring sites.

APPENDIX A

Bison Engineering Inc

Helena, MT 59601

PM10 Particulate Summary

1992 Site & Area: 1111 3

Upwind Site Livingston, MT Envirocon

(Values are in Micrograms per Cubic Meter)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-
4	10	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-
6	-	25	-	-	-	-	-	-	-	-	-	-
7	-	-	14	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	14	-	-	-	-	-	-	-	-	-	-
13	-	-	29	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-
18	-	10	-	-	-	-	-	-	-	-	-	-
19	10	-	13	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-
25	12	-	26	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-
31	14	-	21	-	-	-	-	-	-	-	-	-
No.	4	3	5	0	0	0	0	0	0	0	0	0
Max	14	25	29									
Avg	12	16	21									

Bison Engineering Inc

Helena, MT 59601

PM10 Particulate Summary

1992 Site & Area: 1111 4

Downwind Site Livingston, MT Envirocon

(Values are in Micrograms per Cubic Meter)

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	-	-	14	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-
4	10	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-
6	-	31	-	-	-	-	-	-	-	-	-	-
7	-	-	11	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	14	-	-	-	-	-	-	-	-	-	-
13	16	-	24	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-
18	-	9	-	-	-	-	-	-	-	-	-	-
19	7	-	13	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-
24	-	14	-	-	-	-	-	-	-	-	-	-
25	9	-	34	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-
31	12	-	18	-	-	-	-	-	-	-	-	-
No.	5	4	6	0	0	0	0	0	0	0	0	0
Max	16	31	34									
Avg	11	17	19									

Bison Engineering Inc.
Helena, MT 59601

SUMMARY STATISTICS FOR THE PM10 PARTICULATE DATA

1992

Livingston, MT

Envirocon

Site #	Min	Max	2nd Max	# > 150	Arith. Mean	Arith. Std Dev	Geo. Mean	Geo. Std Dev	Total # Obs.
3	10	29	26	0	17	7	15	1.5	12
4	7	34	31	0	16	8	14	1.6	15

BISON ENGINEERING INC
HELENA, MONTANA

Envircon Livingston, Montana 1st Qrt 1992

*** WIND FREQUENCY SUMMARY ***

DIR---> SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.0 - 4.0	1.6	2.1	1.7	1.2	1.0	0.4	0.1	0.4	1.0	1.2	1.0	0.6	0.4	0.4	0.2	1.2	14.5
4.0 - 7.5	0.8	1.3	1.9	1.4	0.6	0.0	0.0	0.4	0.5	2.1	2.7	1.6	0.2	0.4	0.3	0.8	15.1
7.5 - 12.1	0.6	0.4	1.5	3.0	0.2	0.0	0.2	0.1	0.3	2.8	7.6	6.8	1.5	0.4	0.1	0.2	25.8
12.1 - 19.0	0.1	0.0	0.2	1.2	0.2	0.0	0.0	0.0	0.0	7.4	12.3	5.5	2.8	0.2	0.1	0.1	30.4
19.0 - 24.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	3.9	0.8	0.2	0.0	0.0	0.1	10.3
24.7 - 30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.1	0.4	0.0	0.0	0.0	0.0	3.0
30.0 - 40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.1	0.0	0.0	0.0	0.0	0.9
40.0 - 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVER 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	3.2	3.9	5.4	6.9	2.0	0.4	0.3	0.9	1.9	20.4	29.2	15.9	5.1	1.4	0.8	2.4	
AVG. SPEED	5.7	4.6	6.4	8.8	5.9	3.2	6.7	5.0	5.3	16.0	14.4	12.4	13.1	7.3	6.8	5.7	

Calm Hours = 0.0%

Total Hours With Both Speed and Direction = 2184

Average Wind Speed = 12.0 (MPH)

Resultant Windspeed = 8.3(MPH)

Resultant Wind Direction = 224.9Deg

Wind Persistance = 69.2 %

BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon Livingston, Montana JANUARY 1992

*** TEMPERATURE SUMMARY (DEG F) ***

DAY	HOURS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVG.
1	28	28	28	27	27	27	27	27	28	28	30	32	36	37	37	37	36	36	34	34	34	34	34	32	32
2	32	32	30	32	32	32	32	32	32	34	37	39	41	43	45	43	43	41	41	37	36	36	36	34	36
3	34	32	32	30	30	28	28	28	28	28	32	36	39	41	39	37	34	28	25	23	21	19	18	19	30
4	37	41	41	41	39	39	39	39	37	39	41	43	43	43	43	43	41	39	39	39	39	37	37	37	40
5	39	39	37	37	36	37	37	36	37	39	41	45	43	45	41	39	36	34	32	32	28	27	25	23	36
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13	23	25	23	23	25	23	23	23	25	25	25	27	28	28	28	28	30	30	30	30	30	30	30	30	27
14	30	28	30	30	30	32	30	28	28	27	27	25	25	25	23	21	16	14	10	9	5	5	7	12	22
15	12	12	14	12	14	14	14	14	16	16	18	23	25	27	30	32	32	34	34	34	36	34	34	36	24
16	36	36	37	37	39	39	39	39	39	36	32	32	30	27	25	25	25	23	18	18	14	12	10	7	28
17	3	3	1	16	18	19	19	19	21	21	21	23	23	23	23	23	21	19	18	18	16	18	18	18	18
18	18	18	18	18	18	18	16	16	18	18	19	21	23	25	28	28	30	30	30	30	32	32	30	30	23
19	30	32	32	30	32	30	30	30	30	32	34	36	39	39	41	43	43	41	41	41	39	39	37	37	36
20	36	37	34	34	34	32	32	30	32	32	34	37	39	41	43	43	43	39	37	36	36	34	30	32	36
21	34	32	32	32	32	32	30	30	30	32	34	36	39	41	39	39	37	36	30	30	28	28	30	30	33
22	30	30	30	30	28	28	28	25	25	27	28	28	30	34	34	32	30	30	30	30	30	30	30	32	30
23	32	32	32	30	30	32	32	32	34	36	37	39	41	41	41	43	41	41	39	39	39	39	41	43	37
24	45	43	43	45	45	41	43	46	46	46	46	45	45	46	48	48	46	45	43	45	45	41	39	39	44
25	39	39	39	41	41	43	43	43	45	45	46	50	52	52	52	50	50	48	43	37	39	37	39	39	44
26	39	37	36	36	36	36	34	34	34	37	37	41	45	45	45	45	41	36	32	30	28	34	37	36	37
27	36	36	36	36	36	36	36	34	36	37	41	45	46	48	48	48	48	46	45	45	45	45	45	45	41
28	45	45	45	46	45	46	45	45	46	46	50	52	54	54	55	54	52	50	48	46	46	45	43	41	48
29	41	41	39	39	37	39	37	39	41	43	45	45	48	50	50	48	48	46	45	45	45	45	45	43	43
30	43	43	43	41	41	41	41	39	41	43	45	48	52	54	54	54	52	52	50	48	48	48	48	46	46
31	46	48	48	48	48	48	48	48	46	50	54	55	59	59	59	59	57	57	54	54	52	50	50	50	52
AVG.	32	32	32	32	32	32	32	31	32	33	34	37	38	39	40	39	38	36	35	34	33	32	32	32	

MINIMUM T = 1 MAXIMUM T = 59 AVERAGE T = 34 HOURS OF DATA = 744

BISON ENGINEERING INC.
HELENA, MONTANA

JANUARY 1992

*** *WIND SPEED SUMMARY* ***

HOURS

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVG.
1	16.0	16.0	18.0	20.0	19.0	19.0	18.0	19.0	23.0	25.0	24.0	22.0	19.0	22.0	20.0	19.0	21.0	24.0	25.0	23.0	29.0	31.0	34.0	30.0	22.3
2	32.0	34.0	33.0	29.0	28.0	27.0	29.0	32.0	30.0	24.0	25.0	25.0	26.0	26.0	23.0	19.0	22.0	18.0	19.0	15.0	15.0	16.0	16.0	16.0	24.1
3	22.0	21.0	21.0	21.0	19.0	17.0	14.0	11.0	12.0	14.0	12.0	8.0	10.0	9.0	8.0	7.0	7.0	6.0	3.0	2.0	2.0	4.0	4.0	6.0	10.8
4	9.0	16.0	14.0	17.0	14.0	14.0	15.0	22.0	18.0	17.0	17.0	18.0	19.0	20.0	19.0	16.0	15.0	17.0	20.0	18.0	17.0	20.0	20.0	19.0	17.1
5	21.0	22.0	22.0	21.0	14.0	11.0	13.0	8.0	7.0	10.0	7.0	9.0	9.0	8.0	9.0	13.0	8.0	11.0	8.0	6.0	7.0	4.0	2.0	3.0	10.5
6	3.0	3.0	3.0	2.0	3.0	3.0	3.0	2.0	2.0	1.0	2.0	4.0	5.0	6.0	7.0	6.0	6.0	2.0	1.0	2.0	5.0	3.0	3.0	4.0	3.4
7	7.0	5.0	4.0	12.0	12.0	14.0	14.0	13.0	10.0	12.0	14.0	11.0	10.0	8.0	4.0	4.0	4.0	4.0	3.0	3.0	2.0	3.0	2.0	2.0	7.4
8	8.0	11.0	13.0	15.0	13.0	14.0	14.0	15.0	16.0	16.0	16.0	17.0	14.0	20.0	19.0	17.0	20.0	17.0	16.0	11.0	6.0	7.0	12.0	17.0	14.3
9	20.0	21.0	20.0	21.0	20.0	19.0	20.0	22.0	22.0	20.0	21.0	20.0	20.0	20.0	19.0	20.0	20.0	20.0	19.0	19.0	20.0	20.0	24.0	23.0	20.4
10	22.0	23.0	24.0	23.0	25.0	26.0	26.0	21.0	18.0	25.0	30.0	24.0	23.0	24.0	20.0	18.0	14.0	21.0	22.0	22.0	23.0	26.0	24.0	22.0	22.8
11	22.0	22.0	20.0	13.0	13.0	10.0	11.0	11.0	12.0	8.0	10.0	20.0	18.0	15.0	9.0	10.0	8.0	5.0	3.0	9.0	7.0	11.0	10.0	11.0	12.0
12	10.0	9.0	11.0	5.0	6.0	4.0	2.0	3.0	3.0	4.0	2.0	2.0	6.0	16.0	14.0	12.0	8.0	7.0	6.0	12.0	12.0	13.0	10.0	9.0	7.8
13	11.0	13.0	11.0	9.0	11.0	9.0	11.0	14.0	16.0	15.0	18.0	15.0	15.0	15.0	16.0	15.0	13.0	13.0	13.0	14.0	15.0	13.0	16.0	15.0	13.6
14	15.0	13.0	11.0	12.0	11.0	13.0	17.0	17.0	16.0	19.0	22.0	12.0	9.0	9.0	10.0	7.0	13.0	9.0	7.0	5.0	4.0	5.0	6.0	13.0	11.5
15	14.0	17.0	20.0	19.0	23.0	22.0	24.0	24.0	24.0	24.0	25.0	23.0	24.0	25.0	31.0	26.0	22.0	24.0	25.0	26.0	33.0	34.0	26.0	27.0	24.3
16	31.0	28.0	22.0	19.0	18.0	17.0	18.0	16.0	20.0	19.0	22.0	14.0	9.0	16.0	11.0	8.0	6.0	4.0	4.0	4.0	6.0	6.0	4.0	3.0	13.5
17	1.0	1.0	1.0	12.0	13.0	15.0	15.0	15.0	14.0	12.0	12.0	12.0	12.0	13.0	11.0	8.0	4.0	7.0	11.0	10.0	12.0	12.0	12.0	14.0	10.4
18	14.0	16.0	17.0	15.0	13.0	14.0	16.0	17.0	16.0	16.0	15.0	16.0	14.0	15.0	18.0	17.0	18.0	22.0	21.0	20.0	20.0	22.0	19.0	19.0	17.1
19	23.0	28.0	28.0	27.0	23.0	18.0	16.0	19.0	19.0	17.0	21.0	20.0	21.0	20.0	20.0	18.0	18.0	19.0	20.0	23.0	20.0	20.0	19.0	16.0	20.5
20	18.0	22.0	23.0	25.0	24.0	23.0	23.0	27.0	23.0	21.0	16.0	17.0	14.0	14.0	13.0	12.0	13.0	11.0	9.0	10.0	14.0	10.0	13.0	14.0	17.0
21	15.0	13.0	14.0	15.0	16.0	16.0	18.0	22.0	19.0	18.0	17.0	16.0	13.0	12.0	14.0	20.0	18.0	18.0	17.0	14.0	14.0	17.0	9.0	16.0	15.9
22	16.0	17.0	20.0	20.0	19.0	19.0	19.0	16.0	17.0	17.0	18.0	18.0	17.0	14.0	16.0	17.0	13.0	10.0	15.0	17.0	15.0	16.0	17.0	20.0	16.8
23	20.0	19.0	18.0	20.0	20.0	20.0	22.0	23.0	25.0	26.0	24.0	26.0	24.0	27.0	25.0	22.0	18.0	22.0	20.0	26.0	24.0	24.0	22.0	23.0	22.5
24	29.0	31.0	25.0	27.0	19.0	21.0	22.0	24.0	23.0	19.0	17.0	16.0	15.0	18.0	16.0	15.0	14.0	16.0	11.0	15.0	15.0	13.0	8.0	12.0	18.4
25	14.0	16.0	15.0	17.0	22.0	17.0	19.0	22.0	24.0	25.0	23.0	27.0	26.0	21.0	19.0	18.0	16.0	16.0	16.0	7.0	8.0	6.0	6.0	8.0	17.0
26	16.0	15.0	10.0	8.0	12.0	14.0	8.0	8.0	6.0	12.0	14.0	11.0	7.0	11.0	11.0	6.0	4.0	3.0	3.0	3.0	4.0	10.0	13.0	14.0	9.3
27	17.0	20.0	20.0	18.0	14.0	12.0	13.0	15.0	16.0	18.0	22.0	21.0	21.0	22.0	23.0	24.0	24.0	27.0	27.0	30.0	29.0	27.0	28.0	24.0	21.3
28	23.0	22.0	19.0	20.0	21.0	20.0	18.0	12.0	15.0	22.0	24.0	23.0	25.0	27.0	25.0	26.0	24.0	18.0	19.0	23.0	20.0	16.0	15.0	8.0	20.2
29	9.0	9.0	11.0	15.0	9.0	12.0	11.0	12.0	16.0	22.0	25.0	22.0	24.0	28.0	30.0	21.0	12.0	17.0	22.0	17.0	18.0	17.0	17.0	18.0	17.3
30	19.0	17.0	21.0	20.0	22.0	20.0	24.0	20.0	20.0	23.0	26.0	23.0	22.0	20.0	22.0	21.0	16.0	19.0	20.0	19.0	22.0	22.0	22.0	22.0	20.9
31	22.0	23.0	18.0	16.0	18.0	19.0	19.0	20.0	23.0	23.0	22.0	24.0	18.0	20.0	19.0	17.0	17.0	20.0	21.0	17.0	16.0	14.0	11.0	9.0	18.6
AVG.	16.7	17.5	17.0	17.2	16.6	16.1	16.5	16.8	16.9	17.5	18.2	17.3	16.4	17.5	16.8	15.5	14.1	14.4	14.4	14.3	14.6	14.9	14.3	14.7	

# of Valid Hours = 744

% Data Completeness = 100.0

BISON ENGINEERING INC.
HELENA, MONTANA

JANUARY 1992

*** *WIND DIRECTION SUMMARY* ***

HOURS

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVG.
1	217	216	221	213	219	227	220	215	212	220	217	214	222	221	225	232	232	233	235	232	227	216	233	240	223.5
2	230	218	238	241	230	239	229	236	234	227	211	220	218	204	211	212	207	219	216	250	251	230	248	227	227.0
3	218	214	204	198	195	204	206	196	217	206	194	191	192	171	53	31	32	9	40	21	28	13	358	36	210.4
4	183	194	202	197	206	222	216	209	233	241	227	231	226	219	220	215	212	211	215	206	203	199	217	204	204.3
5	201	205	206	224	226	230	226	157	89	157	150	146	146	175	81	93	17	13	30	60	8	7	354	20	198.5
6	18	12	44	65	340	181	355	23	16	331	69	48	59	55	49	56	82	58	346	202	212	20	11	48	140.1
7	301	248	57	353	355	5	358	356	18	37	31	23	41	71	42	47	75	341	328	307	149	341	19	182	39.6
8	215	228	231	215	222	220	214	222	231	228	232	231	245	259	262	261	256	255	253	253	299	251	236	221	289.0
9	222	222	231	221	216	212	213	221	215	214	207	214	215	222	223	211	226	210	218	222	214	220	231	223	270.0
10	216	200	192	206	193	212	204	212	219	205	211	216	199	200	211	210	240	225	210	205	210	207	204	199	256.6
11	202	201	202	234	232	227	213	233	245	225	232	244	257	254	278	289	276	297	240	243	245	258	235	246	267.9
12	258	257	250	237	315	338	107	92	344	340	182	23	305	252	257	262	267	240	253	243	233	235	239	241	269.8
13	218	222	219	221	223	215	226	221	225	224	212	239	237	229	243	255	244	239	235	233	232	241	230	232	266.4
14	222	240	240	231	244	251	242	250	254	325	341	329	326	343	343	13	346	37	27	38	184	242	213	226	269.8
15	233	221	218	219	217	211	210	212	207	222	207	209	213	221	235	222	207	206	214	237	218	238	249	247	244.2
16	228	225	224	229	221	211	204	215	196	205	210	279	4	48	65	10	329	212	253	211	209	205	20	356	220.2
17	351	35	39	240	226	217	219	213	212	219	223	217	229	217	231	243	259	242	253	245	245	235	238	229	233.6
18	223	215	215	214	221	228	222	217	218	215	217	216	208	212	220	225	223	225	230	230	226	224	228	220	223.9
19	216	211	212	209	216	217	215	225	219	219	218	219	217	212	213	214	218	215	219	221	218	216	217	219	221.5
20	210	211	204	201	204	202	197	194	199	191	195	207	216	230	234	237	223	234	249	238	229	227	239	224	208.7
21	226	231	218	221	206	202	210	206	211	212	210	205	215	213	224	276	273	253	254	247	228	244	201	237	221.7
22	224	240	241	233	233	234	239	230	222	219	219	217	221	240	254	272	284	259	236	233	244	249	258	258	249.9
23	246	250	240	211	222	222	215	222	238	241	241	222	229	221	220	210	192	201	223	212	216	209	201	207	232.8
24	207	211	222	236	236	238	243	243	249	260	262	272	273	266	251	244	244	251	257	249	244	228	218	222	254.9
25	231	205	215	214	222	211	221	214	208	208	207	200	206	210	208	210	212	220	295	225	230	235	251	277	227.9
26	277	261	248	253	259	277	233	229	241	231	220	210	248	275	273	349	18	184	215	201	11	254	214	217	265.0
27	213	221	220	218	229	218	217	241	229	203	203	199	203	210	222	217	214	212	210	204	203	209	209	206	207.6
28	213	209	224	207	207	211	206	217	238	208	208	214	213	217	221	216	211	212	213	215	234	245	240	239	206.1
29	210	246	245	222	236	244	241	250	232	213	217	232	229	234	244	236	211	210	213	217	232	216	228	235	220.4
30	252	248	232	228	250	231	222	222	222	211	207	204	199	212	215	231	233	233	244	219	239	249	236	233	227.1
31	253	259	254	230	223	212	206	214	211	205	207	198	208	208	204	205	204	201	202	201	214	237	277	284	211.4

# of Valid Hours = 744 % Data Completeness = 100.0

BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon Livingston, Montana JANUARY 1992

*** *WIND SIGMA SUMMARY (DEGREES)* ***

HOURS

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVG.
1	12	13	14	10	13	12	12	11	11	12	12	15	17	14	15	15	14	13	13	10	11	12	13	14	13
2	14	15	11	15	20	16	14	14	14	16	15	18	17	12	13	15	13	14	15	18	15	26	17	16	16
3	15	11	11	9	10	12	12	22	15	17	17	38	16	63	19	19	15	21	50	60	51	42	22	56	26
4	63	12	15	10	13	23	16	13	21	16	15	15	13	12	13	14	13	12	12	13	14	15	13	11	16
5	11	11	11	22	21	20	17	73	69	16	20	30	24	47	44	15	31	17	29	24	18	59	76	43	31
6	53	46	54	77	62	80	40	71	25	72	75	26	20	19	17	11	13	53	34	37	24	51	66	40	44
7	29	64	71	14	14	14	12	13	20	12	18	19	16	11	22	32	21	23	20	83	79	58	45	47	32
8	42	13	16	10	11	11	12	10	13	12	15	15	17	15	11	9	7	9	9	28	41	37	17	15	16
9	12	9	13	12	11	13	14	12	11	14	14	14	16	12	18	14	15	10	11	14	11	13	13	15	13
10	13	13	11	12	10	11	9	13	18	16	14	17	12	18	15	17	16	15	12	11	12	11	11	11	13
11	11	11	10	26	18	12	18	20	17	21	17	11	15	13	44	25	57	50	69	27	52	12	21	14	25
12	9	9	8	33	60	41	26	15	36	18	32	41	47	8	10	10	14	20	15	10	11	10	11	15	21
13	14	15	23	20	19	15	15	12	12	13	11	20	21	20	16	13	15	15	10	11	11	16	14	14	15
14	11	15	17	17	22	12	10	9	10	34	10	31	29	17	13	28	14	50	45	62	54	68	70	9	27
15	13	12	11	11	11	13	10	11	11	15	14	13	13	15	16	14	12	18	14	21	11	18	13	12	13
16	13	16	19	19	17	17	22	24	13	10	13	62	39	27	19	19	22	39	58	31	41	14	60	26	27
17	83	44	59	11	12	10	12	12	12	13	10	10	12	11	12	8	39	10	6	7	7	11	14	10	18
18	13	11	10	11	14	12	11	14	12	12	13	14	14	12	10	10	10	18	14	10	11	12	13	16	12
19	14	11	13	12	13	14	14	12	12	12	12	11	13	11	11	12	11	11	15	14	13	11	12	13	12
20	12	13	11	11	11	12	11	11	13	12	14	12	15	14	12	12	13	12	11	17	12	16	10	10	12
21	10	10	14	13	13	18	14	12	12	10	12	11	12	14	13	10	9	12	10	10	16	16	34	13	13
22	10	11	11	16	16	12	11	15	16	18	16	16	15	15	14	9	9	14	14	11	12	11	12	9	13
23	17	12	18	15	14	14	15	15	10	13	19	16	23	18	19	19	15	19	18	17	16	19	14	16	16
24	12	13	17	14	14	14	15	14	13	13	14	16	13	16	12	12	9	7	8	12	16	15	28	13	14
25	18	14	15	19	15	15	16	12	13	13	12	13	12	12	13	12	13	23	36	63	20	27	17	13	18
26	13	15	23	33	10	11	26	13	18	13	12	23	35	13	13	51	22	35	65	41	52	61	11	16	26
27	13	10	9	10	19	10	11	21	18	15	13	11	12	14	13	13	12	11	11	11	11	11	11	13	13
28	13	13	16	13	11	12	13	18	22	13	13	13	12	11	11	12	11	11	11	11	14	10	11	21	13
29	42	13	11	11	16	11	19	16	19	14	13	15	13	11	10	15	16	15	18	20	27	17	21	17	17
30	15	18	13	23	16	12	11	15	17	16	17	18	13	15	14	16	18	14	12	16	17	14	17	19	16
31	11	12	18	20	19	13	13	14	13	12	14	13	15	13	12	12	13	11	10	12	16	21	21	31	15
AVG.	20	16	18	18	18	17	15	18	17	17	17	19	18	17	16	16	17	19	22	24	23	24	23	19	

BISON ENGINEERING INC.
HELENA, MONTANA

JANUARY 1992

*** WIND FREQUENCY SUMMARY ***

DIR---> SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.0 - 4.0	1.1	1.7	1.1	0.7	0.1	0.1	0.0	0.1	0.7	0.5	0.1	0.4	0.0	0.0	0.1	1.2	8.1
4.0 - 7.5	0.3	0.5	0.7	0.3	0.3	0.0	0.0	0.1	0.0	0.5	0.3	1.5	0.0	0.4	0.3	0.3	5.4
7.5 - 12.1	0.5	0.7	0.5	0.3	0.1	0.0	0.3	0.3	0.5	1.2	4.7	4.6	1.1	0.3	0.1	0.4	15.6
12.1 - 19.0	0.4	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	7.9	18.4	7.1	1.7	0.3	0.1	0.1	36.6
19.0 - 24.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	12.5	9.9	2.3	0.1	0.0	0.0	0.1	25.1
24.7 - 30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	2.8	1.2	0.0	0.0	0.0	0.0	7.8
30.0 - 40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.1	0.3	0.0	0.0	0.0	0.0	1.5
40.0 - 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVER 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	2.3	3.1	2.4	1.2	0.7	0.1	0.3	0.5	1.3	26.6	37.4	17.3	3.0	0.9	0.7	2.2	
AVG. SPEED	7.0	5.5	6.1	4.9	7.6	2.0	9.0	6.7	6.9	20.0	18.0	15.1	14.2	9.4	8.6	6.5	

Calm Hours = 0.0%

Total Hours With Both Speed and Direction = 744

Average Wind Speed = 16.1 (MPH)

Resultant Windspeed = 13.9 (MPH)

Resultant Wind Direction = 223.0 Deg

Wind Persistance = 86.4 %

BISON ENGINEERING INC.
HELENA, MONTANA

FEBRUARY 1992

*** WIND SPEED SUMMARY ***

HOURS

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVG.
1	12.0	13.0	13.0	11.0	7.0	6.0	6.0	5.0	9.0	11.0	8.0	5.0	7.0	22.0	22.0	22.0	19.0	15.0	7.0	10.0	14.0	15.0	14.0	13.0	11.9
2	14.0	13.0	15.0	14.0	12.0	8.0	9.0	11.0	15.0	15.0	11.0	14.0	16.0	18.0	17.0	16.0	13.0	6.0	6.0	6.0	6.0	8.0	8.0	5.0	11.5
3	3.0	2.0	5.0	3.0	3.0	4.0	7.0	8.0	10.0	10.0	11.0	12.0	12.0	11.0	7.0	6.0	10.0	10.0	11.0	13.0	12.0	13.0	12.0	15.0	8.8
4	16.0	16.0	17.0	17.0	18.0	16.0	18.0	18.0	17.0	19.0	17.0	15.0	13.0	12.0	9.0	9.0	11.0	11.0	12.0	13.0	14.0	14.0	14.0	14.0	14.6
5	16.0	15.0	15.0	14.0	14.0	15.0	11.0	13.0	13.0	11.0	12.0	11.0	11.0	9.0	7.0	6.0	6.0	8.0	10.0	11.0	14.0	11.0	11.0	14.0	11.6
6	14.0	15.0	14.0	15.0	15.0	14.0	12.0	14.0	14.0	15.0	17.0	16.0	10.0	9.0	8.0	6.0	5.0	7.0	7.0	5.0	4.0	7.0	5.0	6.0	10.6
7	6.0	8.0	9.0	6.0	1.0	2.0	2.0	3.0	1.0	3.0	3.0	3.0	5.0	6.0	8.0	9.0	6.0	4.0	5.0	5.0	3.0	3.0	3.0	2.0	4.4
8	4.0	3.0	1.0	3.0	4.0	3.0	7.0	4.0	7.0	13.0	12.0	10.0	10.0	11.0	9.0	12.0	13.0	14.0	10.0	10.0	9.0	13.0	18.0	16.0	9.0
9	12.0	13.0	10.0	12.0	12.0	10.0	12.0	12.0	10.0	9.0	8.0	13.0	14.0	15.0	16.0	13.0	10.0	11.0	6.0	4.0	3.0	3.0	3.0	6.0	9.9
10	9.0	9.0	9.0	10.0	9.0	7.0	7.0	8.0	10.0	8.0	9.0	8.0	9.0	10.0	9.0	11.0	14.0	13.0	13.0	12.0	11.0	12.0	12.0	10.0	10.0
11	10.0	10.0	10.0	9.0	8.0	9.0	9.0	7.0	7.0	6.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	3.0	1.0	3.0	3.0	4.0	5.0	5.1
12	6.0	9.0	14.0	11.0	11.0	13.0	10.0	9.0	14.0	14.0	10.0	14.0	15.0	12.0	17.0	17.0	16.0	13.0	13.0	17.0	15.0	12.0	11.0	13.0	12.8
13	9.0	10.0	9.0	9.0	6.0	5.0	5.0	6.0	6.0	4.0	5.0	6.0	9.0	9.0	13.0	14.0	8.0	9.0	6.0	10.0	8.0	7.0	4.0	5.0	7.6
14	6.0	11.0	12.0	12.0	11.0	13.0	11.0	11.0	8.0	9.0	10.0	9.0	9.0	9.0	10.0	13.0	11.0	8.0	10.0	13.0	15.0	14.0	15.0	15.0	11.0
15	15.0	13.0	11.0	12.0	14.0	11.0	8.0	5.0	5.0	8.0	12.0	15.0	19.0	20.0	19.0	18.0	18.0	14.0	12.0	14.0	12.0	11.0	12.0	10.0	12.8
16	13.0	13.0	8.0	6.0	6.0	7.0	4.0	2.0	4.0	7.0	7.0	12.0	13.0	10.0	8.0	11.0	13.0	8.0	15.0	14.0	11.0	10.0	9.0	5.0	9.0
17	2.0	1.0	7.0	9.0	10.0	12.0	8.0	8.0	8.0	10.0	11.0	12.0	16.0	16.0	13.0	14.0	11.0	8.0	6.0	5.0	3.0	4.0	4.0	9.0	8.6
18	15.0	13.0	13.0	11.0	11.0	13.0	11.0	11.0	13.0	15.0	17.0	19.0	17.0	16.0	20.0	22.0	21.0	23.0	23.0	20.0	22.0	24.0	24.0	23.0	17.4
19	26.0	28.0	29.0	29.0	31.0	34.0	33.0	32.0	32.0	33.0	32.0	32.0	33.0	29.0	26.0	13.0	23.0	22.0	22.0	18.0	19.0	18.0	17.0	13.0	26.0
20	12.0	14.0	15.0	13.0	12.0	11.0	10.0	12.0	11.0	9.0	8.0	6.0	5.0	3.0	4.0	6.0	8.0	6.0	6.0	5.0	6.0	3.0	6.0	4.0	8.1
21	9.0	12.0	12.0	12.0	7.0	9.0	11.0	8.0	8.0	7.0	18.0	23.0	23.0	24.0	25.0	20.0	23.0	26.0	21.0	19.0	20.0	17.0	11.0	11.0	15.7
22	9.0	11.0	12.0	9.0	13.0	13.0	10.0	16.0	18.0	12.0	19.0	17.0	17.0	14.0	16.0	14.0	12.0	10.0	10.0	3.0	5.0	7.0	7.0	13.0	12.0
23	14.0	14.0	13.0	12.0	8.0	9.0	10.0	6.0	3.0	3.0	6.0	6.0	14.0	14.0	15.0	17.0	16.0	12.0	10.0	11.0	13.0	14.0	13.0	15.0	11.2
24	19.0	22.0	19.0	19.0	19.0	19.0	24.0	21.0	17.0	15.0	15.0	13.0	17.0	16.0	15.0	14.0	12.0	10.0	4.0	6.0	7.0	7.0	4.0	3.0	14.0
25	7.0	4.0	3.0	5.0	5.0	5.0	7.0	9.0	10.0	11.0	15.0	20.0	21.0	20.0	19.0	19.0	17.0	11.0	6.0	5.0	8.0	10.0	12.0	13.0	10.9
26	10.0	12.0	11.0	10.0	14.0	10.0	10.0	13.0	14.0	16.0	14.0	12.0	13.0	19.0	22.0	19.0	15.0	13.0	10.0	10.0	10.0	11.0	13.0	11.0	13.0
27	12.0	13.0	12.0	12.0	13.0	16.0	16.0	19.0	18.0	18.0	16.0	15.0	16.0	15.0	14.0	18.0	19.0	13.0	13.0	11.0	12.0	14.0	14.0	14.0	14.7
28	14.0	15.0	15.0	16.0	14.0	16.0	17.0	18.0	20.0	18.0	19.0	18.0	18.0	15.0	12.0	10.0	9.0	7.0	9.0	6.0	14.0	17.0	15.0	19.0	14.6
29	19.0	16.0	19.0	13.0	12.0	17.0	16.0	18.0	19.0	21.0	21.0	20.0	17.0	11.0	14.0	15.0	12.0	11.0	9.0	14.0	15.0	15.0	15.0	11.0	15.4
AVG.	11.5	12.0	12.1	11.5	11.0	11.3	11.1	11.3	11.8	12.1	12.6	13.0	13.8	13.7	13.7	13.3	12.9	11.2	10.2	10.0	10.6	10.9	10.7	10.8	

\# of Valid Hours = 696 % Data Completeness = 100.0

BISON ENGINEERING INC.
HELENA, MONTANA

FEBRUARY 1992

*** *WIND SPEED SUMMARY* ***

HOURS

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVG.
1	12.0	13.0	13.0	11.0	7.0	6.0	6.0	5.0	9.0	11.0	8.0	5.0	7.0	22.0	22.0	22.0	19.0	15.0	7.0	10.0	14.0	15.0	14.0	13.0	11.9
2	14.0	13.0	15.0	14.0	12.0	8.0	9.0	11.0	15.0	15.0	11.0	14.0	16.0	18.0	17.0	16.0	13.0	6.0	6.0	6.0	6.0	8.0	8.0	5.0	11.5
3	3.0	2.0	5.0	3.0	3.0	4.0	7.0	8.0	10.0	10.0	11.0	12.0	12.0	11.0	7.0	6.0	10.0	10.0	11.0	13.0	12.0	13.0	12.0	15.0	8.8
4	16.0	16.0	17.0	17.0	18.0	16.0	18.0	18.0	17.0	19.0	17.0	15.0	13.0	12.0	9.0	9.0	11.0	11.0	12.0	13.0	14.0	14.0	14.0	14.0	14.6
5	16.0	15.0	15.0	14.0	14.0	15.0	11.0	13.0	13.0	11.0	12.0	11.0	11.0	9.0	7.0	6.0	6.0	8.0	10.0	11.0	14.0	11.0	11.0	14.0	11.6
6	14.0	15.0	14.0	15.0	15.0	14.0	12.0	14.0	14.0	15.0	17.0	16.0	10.0	9.0	8.0	6.0	5.0	7.0	7.0	5.0	4.0	7.0	5.0	6.0	10.6
7	6.0	8.0	9.0	6.0	1.0	2.0	2.0	3.0	1.0	3.0	3.0	3.0	5.0	6.0	8.0	9.0	6.0	4.0	5.0	5.0	3.0	3.0	3.0	2.0	4.4
8	4.0	3.0	1.0	3.0	4.0	3.0	7.0	4.0	7.0	13.0	12.0	10.0	10.0	11.0	9.0	12.0	13.0	14.0	10.0	10.0	9.0	13.0	18.0	16.0	9.0
9	12.0	13.0	10.0	12.0	12.0	10.0	12.0	12.0	10.0	9.0	8.0	13.0	14.0	15.0	16.0	13.0	10.0	11.0	6.0	4.0	3.0	3.0	3.0	6.0	9.9
10	9.0	9.0	9.0	10.0	9.0	7.0	7.0	8.0	10.0	8.0	9.0	8.0	9.0	10.0	9.0	11.0	14.0	13.0	13.0	12.0	11.0	12.0	12.0	10.0	10.0
11	10.0	10.0	10.0	9.0	8.0	9.0	9.0	7.0	7.0	6.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	3.0	1.0	3.0	3.0	4.0	5.0	5.1
12	6.0	9.0	14.0	11.0	11.0	13.0	10.0	9.0	14.0	14.0	10.0	14.0	15.0	12.0	17.0	17.0	16.0	13.0	13.0	17.0	15.0	12.0	11.0	13.0	12.8
13	9.0	10.0	9.0	9.0	6.0	5.0	5.0	6.0	6.0	4.0	5.0	6.0	9.0	9.0	13.0	14.0	8.0	9.0	6.0	10.0	8.0	7.0	4.0	5.0	7.6
14	6.0	11.0	12.0	12.0	11.0	13.0	11.0	11.0	8.0	9.0	10.0	9.0	9.0	9.0	10.0	13.0	11.0	8.0	10.0	13.0	15.0	14.0	15.0	15.0	11.0
15	15.0	13.0	11.0	12.0	14.0	11.0	8.0	5.0	5.0	8.0	12.0	15.0	19.0	20.0	19.0	18.0	18.0	14.0	12.0	14.0	12.0	11.0	12.0	10.0	12.8
16	13.0	13.0	8.0	6.0	6.0	7.0	4.0	2.0	4.0	7.0	7.0	12.0	13.0	10.0	8.0	11.0	13.0	8.0	15.0	14.0	11.0	10.0	9.0	5.0	9.0
17	2.0	1.0	7.0	9.0	10.0	12.0	8.0	8.0	8.0	10.0	11.0	12.0	16.0	16.0	13.0	14.0	11.0	8.0	6.0	5.0	3.0	4.0	4.0	9.0	8.6
18	15.0	13.0	13.0	11.0	11.0	13.0	11.0	11.0	13.0	15.0	17.0	19.0	17.0	16.0	20.0	22.0	21.0	23.0	23.0	20.0	22.0	24.0	24.0	23.0	17.4
19	26.0	28.0	29.0	29.0	31.0	34.0	33.0	32.0	32.0	33.0	32.0	32.0	33.0	29.0	26.0	13.0	23.0	22.0	22.0	18.0	19.0	18.0	17.0	13.0	26.0
20	12.0	14.0	15.0	13.0	12.0	11.0	10.0	12.0	11.0	9.0	8.0	6.0	5.0	3.0	4.0	6.0	8.0	6.0	6.0	5.0	6.0	3.0	6.0	4.0	8.1
21	9.0	12.0	12.0	12.0	7.0	9.0	11.0	8.0	8.0	7.0	18.0	23.0	23.0	24.0	25.0	20.0	23.0	26.0	21.0	19.0	20.0	17.0	11.0	11.0	15.7
22	9.0	11.0	12.0	9.0	13.0	13.0	10.0	16.0	18.0	12.0	19.0	17.0	17.0	14.0	16.0	14.0	12.0	10.0	10.0	3.0	5.0	7.0	7.0	13.0	12.0
23	14.0	14.0	13.0	12.0	8.0	9.0	10.0	6.0	3.0	3.0	6.0	6.0	14.0	14.0	15.0	17.0	16.0	12.0	10.0	11.0	13.0	14.0	13.0	15.0	11.2
24	19.0	22.0	19.0	19.0	19.0	19.0	24.0	21.0	17.0	15.0	15.0	13.0	17.0	16.0	15.0	14.0	12.0	10.0	4.0	6.0	7.0	7.0	4.0	3.0	14.0
25	7.0	4.0	3.0	5.0	5.0	5.0	7.0	9.0	10.0	11.0	15.0	20.0	21.0	20.0	19.0	19.0	17.0	11.0	6.0	5.0	8.0	10.0	12.0	13.0	10.9
26	10.0	12.0	11.0	10.0	14.0	10.0	10.0	13.0	14.0	16.0	14.0	12.0	13.0	19.0	22.0	19.0	15.0	13.0	10.0	10.0	10.0	11.0	13.0	11.0	13.0
27	12.0	13.0	12.0	12.0	13.0	16.0	16.0	19.0	18.0	18.0	16.0	15.0	16.0	15.0	14.0	18.0	19.0	13.0	13.0	11.0	12.0	14.0	14.0	14.0	14.7
28	14.0	15.0	15.0	16.0	14.0	16.0	17.0	18.0	20.0	18.0	19.0	18.0	18.0	15.0	12.0	10.0	9.0	7.0	9.0	6.0	14.0	17.0	15.0	19.0	14.6
29	19.0	16.0	19.0	13.0	12.0	17.0	16.0	18.0	19.0	21.0	21.0	20.0	17.0	11.0	14.0	15.0	12.0	11.0	9.0	14.0	15.0	15.0	15.0	11.0	15.4
AVG.	11.5	12.0	12.1	11.5	11.0	11.3	11.1	11.3	11.8	12.1	12.6	13.0	13.8	13.7	13.7	13.3	12.9	11.2	10.2	10.0	10.6	10.9	10.7	10.8	

\# of Valid Hours = 696

% Data Completeness = 100.0

BISON ENGINEERING INC.
HELENA, MONTANA

FEBRUARY 1992

*** *WIND DIRECTION SUMMARY* ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	239	254	255	248	261	253	47	297	213	190	218	243	343	214	222	230	233	222	174	166	202	204	212	214	221.1
2	218	245	231	226	221	221	225	231	221	218	210	239	262	256	250	251	248	224	219	235	215	211	222	219	228.3
3	33	171	97	31	56	138	230	207	215	213	221	209	210	212	217	219	223	235	247	243	244	245	236	221	225.6
4	221	221	218	219	216	216	218	212	216	216	220	216	218	220	231	241	233	235	235	243	244	231	231	229	223.5
5	222	219	222	227	218	221	224	218	219	235	235	241	232	227	227	228	238	231	232	230	242	246	241	221	222.8
6	225	218	216	210	208	214	206	221	217	217	222	224	234	239	234	236	239	222	217	174	206	213	208	210	222.2
7	209	227	233	215	60	121	30	12	98	89	24	11	11	56	62	75	49	343	327	337	8	197	215	224	189.5
8	216	239	7	242	203	104	235	226	237	248	244	231	236	207	219	256	271	278	246	237	236	211	215	259	152.7
9	234	279	263	238	246	246	241	231	247	245	235	245	258	267	260	258	256	266	59	40	24	290	190	10	310.1
10	49	57	53	62	59	55	59	51	68	75	63	69	61	58	68	67	60	63	63	64	62	66	68	63	66.9
11	62	67	67	69	67	59	66	59	60	60	69	13	359	356	55	157	97	93	291	202	187	90	44	138	67.6
12	202	245	227	243	223	228	211	215	213	237	242	206	209	236	223	218	223	218	208	209	212	221	213	219	122.9
13	232	224	228	231	203	163	148	165	6	26	190	182	194	267	261	263	215	228	220	201	230	241	256	227	218.8
14	243	255	234	233	237	238	232	232	236	203	223	221	217	215	208	249	213	236	240	236	211	210	207	208	219.7
15	210	216	227	240	215	237	268	17	50	191	210	211	208	211	208	212	210	214	200	202	205	223	263	237	208.2
16	223	227	225	242	217	193	184	295	191	214	213	195	204	202	291	280	292	262	255	234	241	242	239	206	231.7
17	21	343	236	242	249	251	249	256	239	232	237	257	276	273	259	265	256	273	324	227	25	60	57	226	280.0
18	210	216	209	234	235	226	225	246	223	211	206	213	210	212	203	214	202	201	203	203	205	207	206	204	255.2
19	207	207	207	210	212	212	213	214	218	217	218	219	217	212	205	202	207	206	200	207	218	217	220	223	244.3
20	212	64	70	73	74	80	76	78	72	67	63	57	52	47	40	43	56	27	14	237	339	208	260	239	334.8
21	267	265	251	260	242	256	260	240	230	244	210	207	206	213	221	223	225	229	218	229	222	264	259	254	283.0
22	240	224	233	243	216	227	229	222	247	233	241	254	253	253	244	244	272	281	271	336	237	235	249	261	259.0
23	278	247	232	229	236	217	239	298	78	94	21	334	260	254	257	262	256	236	250	238	239	226	223	220	255.1
24	216	225	224	223	219	234	220	229	247	233	233	225	250	257	269	266	261	244	236	212	232	225	234	160	239.1
25	228	177	170	189	206	213	230	238	237	220	261	273	265	259	267	270	265	253	236	214	229	243	243	238	259.9
26	243	234	236	239	217	226	229	221	218	210	209	213	222	260	261	263	262	255	249	233	242	238	238	245	258.6
27	241	239	231	228	219	210	213	208	209	208	203	208	212	211	221	256	242	249	242	242	238	227	222	214	221.2
28	210	209	221	228	219	217	217	208	211	208	204	202	199	204	200	237	276	243	210	206	221	226	237	232	209.1
29	223	203	216	241	229	223	229	217	228	220	215	202	229	246	265	269	235	228	218	210	207	214	209	227	219.5

# of Valid Hours =   696   % Data Completeness = 100.0

BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon Livingston, Montana FEBRUARY 1992

*** WIND SIGMA SUMMARY (DEGREES) ***

HOURS

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVG.
1	23	18	17	20	32	41	74	62	28	22	23	51	57	30	11	11	13	14	41	30	13	11	15	14	28
2	14	15	17	11	10	16	14	9	12	15	20	24	11	8	10	8	9	19	13	37	28	11	13	28	16
3	84	67	50	37	33	65	35	21	12	14	12	12	10	12	17	14	11	11	11	12	10	10	13	10	24
4	9	11	10	11	11	11	10	12	12	13	11	11	11	13	17	13	9	8	9	8	7	11	9	12	11
5	11	10	11	12	9	11	13	14	15	12	13	13	11	12	14	18	14	8	7	10	9	7	10	11	11
6	9	12	11	12	12	15	15	12	13	11	12	11	15	14	12	16	9	8	10	84	47	17	14	12	17
7	15	7	7	29	39	65	77	43	57	27	41	51	52	28	17	12	23	24	19	13	23	62	13	10	31
8	13	58	38	47	46	69	19	39	53	13	12	16	14	14	22	16	10	6	16	16	26	16	17	21	26
9	28	14	27	17	9	9	9	15	11	13	18	19	12	13	12	12	11	7	80	75	35	80	52	25	25
10	42	22	21	18	12	18	14	11	10	14	13	17	17	14	10	11	10	10	12	10	11	10	10	10	14
11	10	9	9	10	11	9	9	10	10	14	38	34	46	82	50	46	49	37	72	42	17	72	47	81	34
12	74	14	14	13	19	14	13	13	13	14	18	17	15	22	16	14	13	15	15	13	12	12	12	14	17
13	24	40	34	18	31	55	21	35	34	40	51	47	18	24	10	13	19	17	16	11	15	12	51	15	27
14	17	10	12	12	9	11	11	16	14	18	13	14	17	24	38	13	13	12	17	21	13	13	14	14	15
15	16	18	19	15	12	29	14	74	37	54	15	15	13	12	13	12	12	11	11	11	12	21	22	26	21
16	14	15	18	45	45	20	54	76	56	23	31	18	15	18	30	31	20	37	19	12	12	13	15	59	29
17	13	73	16	8	7	8	14	9	10	10	12	14	8	8	9	9	8	28	60	44	35	22	32	26	20
18	11	11	13	18	27	16	23	22	22	16	17	13	16	14	14	12	11	11	11	12	10	11	13	13	15
19	13	11	12	13	12	11	11	11	11	11	11	11	11	11	21	14	14	16	13	16	15	14	14	13	13
20	13	45	10	11	11	10	10	11	11	11	15	23	29	33	45	28	14	18	24	79	69	75	45	75	30
21	17	20	23	8	28	21	38	10	21	24	16	13	15	12	11	12	15	17	13	16	18	14	23	17	18
22	28	16	19	24	14	15	16	12	13	15	13	12	13	13	12	14	25	25	34	63	69	13	15	17	21
23	25	9	10	11	11	12	12	54	27	48	35	64	24	12	12	11	9	12	9	11	10	13	17	14	20
24	12	15	18	17	16	17	18	17	17	15	16	15	15	10	11	9	12	8	53	39	29	23	69	60	22
25	9	34	46	28	42	12	15	9	10	16	16	10	13	10	11	12	11	14	89	39	10	13	10	11	20
26	9	11	14	15	14	11	10	14	11	12	12	17	19	12	8	10	10	9	15	13	8	9	9	10	12
27	9	9	14	10	13	12	12	11	12	10	11	11	13	14	20	10	12	12	20	14	12	11	14	12	12
28	11	10	12	13	15	14	13	11	12	13	11	11	10	12	12	36	10	23	10	23	14	13	11	14	14
29	13	10	17	15	20	14	15	11	15	15	14	14	15	28	13	10	24	12	13	10	10	11	10	24	15
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
AVG.	20	21	19	18	20	22	21	23	20	18	19	21	18	18	17	15	14	15	25	27	21	21	21	23	

BISON ENGINEERING INC.
HELENA, MONTANA

FEBRUARY 1992

*** *WIND FREQUENCY SUMMARY* ***

DIR---> SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.0 - 4.0	0.7	1.4	0.9	0.7	0.9	0.3	0.1	0.3	1.0	0.7	0.9	0.6	0.0	0.4	0.0	0.4	9.3
4.0 - 7.5	0.4	0.6	1.0	0.9	0.1	0.0	0.1	0.4	0.7	2.2	3.7	2.0	0.3	0.3	0.1	0.7	13.6
7.5 - 12.1	0.0	0.0	0.6	4.5	0.1	0.0	0.0	0.1	0.3	3.7	12.5	9.9	2.4	0.1	0.0	0.0	34.3
12.1 - 19.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	9.1	14.4	6.9	3.9	0.1	0.0	0.0	35.2
19.0 - 24.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	1.6	0.1	0.4	0.0	0.0	0.0	5.0
24.7 - 30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.3	0.0	0.0	0.0	0.0	0.0	1.1
30.0 - 40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.0	0.0	0.0	0.0	0.0	1.3
40.0 - 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVER 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	1.1	2.0	2.4	6.9	1.1	0.3	0.3	0.9	2.0	20.0	34.1	19.5	7.0	1.0	0.1	1.1	
AVG. SPEED	3.5	3.6	5.6	9.1	3.9	2.5	4.5	5.3	5.0	15.2	12.9	11.3	13.6	5.7	6.0	4.6	

Calm Hours = 0.0%

Total Hours With Both Speed and Direction = 696

Average Wind Speed = 11.8 (MPH)

Resultant Windspeed = 9.2 (MPH)

Resultant Wind Direction = 225.8 Deg

Wind Persistance = 77.6 %

BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon Livingston, Montana MARCH 1992

*** *TEMPERATURE SUMMARY (DEG F)* ***

DAY	HOURS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVG.
1	48	50	48	48	46	46	46	45	48	50	52	55	57	59	61	61	59	57	54	55	54	48	46	43	52
2	37	36	36	41	37	45	46	48	48	50	54	55	57	57	59	57	57	55	55	54	52	48	45	39	49
3	36	36	36	36	34	36	30	32	37	46	52	57	59	59	59	59	61	57	52	50	48	45	41	39	46
4	39	39	36	36	36	32	34	39	41	48	52	55	57	59	59	61	57	55	52	50	46	46	43	43	46
5	39	36	34	34	34	30	30	32	37	46	50	52	52	54	54	54	52	52	50	48	46	46	45	43	44
6	41	39	37	37	36	36	37	37	39	41	45	45	46	48	48	50	48	46	45	43	41	36	37	36	41
7	37	32	36	37	37	36	36	36	36	39	46	52	54	55	54	54	52	48	45	43	37	34	32	32	42
8	32	32	30	30	28	28	28	28	28	28	28	28	28	28	30	30	28	28	27	27	27	27	25	27	28
9	27	27	27	28	28	28	27	21	25	28	34	36	37	39	41	41	39	37	34	34	32	34	34	34	32
10	34	34	34	36	36	36	34	36	37	41	43	45	46	46	48	48	48	48	45	41	37	36	34	32	40
11	32	30	34	36	36	36	34	36	39	43	46	50	52	52	54	54	54	52	46	43	39	37	39	39	42
12	41	41	39	41	39	39	39	39	43	45	50	54	57	57	59	59	59	57	52	46	43	41	43	41	47
13	39	37	39	39	39	39	39	41	43	45	48	54	55	59	61	61	61	57	52	46	43	41	39	37	46
14	34	30	28	28	28	28	27	28	34	41	46	52	57	61	63	64	63	61	55	52	48	45	41	37	44
15	34	34	32	37	45	45	45	45	48	50	54	57	63	63	57	57	59	59	55	54	50	46	45	46	49
16	43	41	39	36	36	37	37	39	43	48	50	54	54	54	50	48	46	43	41	39	37	36	36	34	43
17	34	34	32	34	34	34	34	34	34	36	36	37	39	39	41	43	41	37	36	34	32	32	32	32	35
18	32	32	32	32	32	32	32	32	34	36	36	36	37	39	41	41	41	39	37	36	36	34	34	32	35
19	34	34	34	36	36	34	34	36	36	37	39	41	45	46	46	48	48	48	45	45	45	43	43	41	40
20	43	43	39	41	43	39	39	41	41	43	43	45	46	46	43	39	36	36	34	32	30	30	30	28	39
21	28	28	28	27	27	27	25	28	30	30	34	36	37	39	39	41	41	41	37	34	30	28	28	28	32
22	28	28	28	28	28	28	28	28	32	34	37	41	46	50	54	55	55	54	48	41	41	41	43	41	39
23	41	41	39	37	37	37	36	37	39	43	46	52	54	54	54	54	54	54	50	46	45	43	45	41	45
24	39	39	37	37	37	34	34	34	32	32	32	34	39	41	43	43	43	41	39	36	32	32	30	34	36
25	34	36	37	37	36	36	36	39	43	46	50	52	54	54	55	57	57	55	52	46	41	43	41	36	45
26	36	36	32	30	27	32	37	39	43	48	52	54	57	59	61	61	61	57	54	50	48	45	41	37	46
27	37	43	48	46	46	46	46	46	48	50	48	48	46	46	50	54	54	52	50	48	46	46	45	45	47
28	43	41	41	39	39	39	39	39	41	45	48	52	52	54	55	54	52	48	46	43	41	37	36	36	44
29	34	32	32	30	28	27	27	32	37	37	41	46	48	50	52	54	54	52	50	46	43	39	37	37	40
30	34	32	30	28	28	28	30	32	39	45	52	59	61	63	61	57	59	55	52	50	48	46	41	39	45
31	41	43	41	37	36	36	34	34	34	37	41	45	48	50	52	52	52	50	48	45	39	37	34	32	42
AVG.	36	36	35	36	35	35	35	36	38	42	45	48	50	51	52	52	51	49	46	44	41	39	38	37	

MINIMUM T = 21   MAXIMUM T = 64   AVERAGE T = 42   HOURS OF DATA = 744

BISON ENGINEERING INC.
HELENA, MONTANA

MARCH 1992

*** *WIND SPEED SUMMARY* ***

DAY	HOURS																								AVG.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1	13.0	14.0	11.0	12.0	15.0	15.0	17.0	14.0	16.0	13.0	16.0	16.0	16.0	17.0	16.0	15.0	9.0	3.0	6.0	14.0	10.0	5.0	6.0	4.0	12.2
2	5.0	3.0	3.0	5.0	5.0	12.0	13.0	16.0	17.0	16.0	17.0	18.0	16.0	16.0	16.0	18.0	16.0	14.0	12.0	11.0	5.0	2.0	2.0	3.0	10.9
3	4.0	4.0	5.0	6.0	5.0	5.0	5.0	5.0	4.0	4.0	6.0	4.0	6.0	7.0	9.0	10.0	12.0	11.0	6.0	7.0	4.0	3.0	3.0	4.0	5.8
4	7.0	7.0	3.0	2.0	3.0	3.0	4.0	9.0	9.0	8.0	7.0	5.0	7.0	5.0	5.0	6.0	12.0	13.0	13.0	4.0	3.0	6.0	7.0	7.0	6.5
5	3.0	1.0	3.0	1.0	2.0	3.0	1.0	2.0	2.0	2.0	2.0	3.0	5.0	6.0	7.0	7.0	6.0	5.0	4.0	3.0	4.0	4.0	3.0	5.0	3.5
6	3.0	3.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	1.0	2.0	8.0	6.0	5.0	5.0	5.0	7.0	9.0	7.0	5.0	3.0	2.0	5.0	6.0	4.0
7	6.0	2.0	6.0	6.0	8.0	4.0	5.0	6.0	5.0	4.0	7.0	9.0	10.0	8.0	9.0	9.0	10.0	12.0	13.0	12.0	9.0	6.0	7.0	9.0	7.6
8	12.0	12.0	12.0	12.0	11.0	12.0	16.0	14.0	15.0	17.0	19.0	19.0	18.0	16.0	15.0	16.0	15.0	14.0	13.0	11.0	9.0	5.0	2.0	3.0	12.8
9	4.0	5.0	4.0	6.0	10.0	8.0	6.0	4.0	4.0	4.0	5.0	14.0	14.0	14.0	12.0	10.0	8.0	5.0	2.0	4.0	4.0	9.0	10.0	9.0	7.3
10	11.0	15.0	13.0	12.0	10.0	11.0	10.0	11.0	15.0	15.0	17.0	18.0	16.0	18.0	16.0	13.0	12.0	8.0	5.0	2.0	3.0	3.0	3.0	2.0	10.8
11	3.0	3.0	6.0	10.0	10.0	11.0	11.0	12.0	14.0	13.0	13.0	17.0	19.0	19.0	18.0	16.0	9.0	6.0	3.0	4.0	5.0	5.0	6.0	7.0	10.0
12	10.0	11.0	11.0	13.0	12.0	12.0	12.0	12.0	14.0	13.0	13.0	11.0	18.0	19.0	15.0	9.0	6.0	4.0	3.0	4.0	7.0	6.0	6.0	6.0	10.3
13	4.0	4.0	9.0	6.0	13.0	13.0	13.0	12.0	10.0	6.0	7.0	8.0	7.0	6.0	5.0	8.0	8.0	9.0	7.0	6.0	2.0	4.0	5.0	5.0	7.4
14	3.0	1.0	1.0	1.0	2.0	2.0	2.0	3.0	3.0	3.0	5.0	5.0	4.0	4.0	4.0	7.0	10.0	9.0	6.0	4.0	4.0	3.0	3.0	4.0	3.9
15	5.0	5.0	5.0	6.0	7.0	9.0	9.0	6.0	7.0	15.0	13.0	16.0	14.0	17.0	13.0	7.0	8.0	5.0	7.0	5.0	3.0	2.0	4.0	4.0	8.0
16	4.0	3.0	5.0	2.0	5.0	7.0	6.0	7.0	5.0	8.0	11.0	8.0	7.0	7.0	9.0	7.0	8.0	15.0	14.0	13.0	13.0	12.0	12.0	11.0	8.3
17	13.0	12.0	10.0	9.0	8.0	8.0	6.0	7.0	8.0	6.0	5.0	3.0	3.0	4.0	3.0	3.0	8.0	11.0	6.0	3.0	3.0	2.0	2.0	1.0	6.0
18	1.0	1.0	1.0	1.0	1.0	1.0	3.0	4.0	6.0	9.0	10.0	12.0	9.0	7.0	8.0	7.0	7.0	6.0	5.0	4.0	2.0	3.0	4.0	5.0	4.9
19	6.0	8.0	8.0	12.0	11.0	8.0	8.0	9.0	11.0	13.0	14.0	12.0	11.0	10.0	10.0	10.0	10.0	11.0	8.0	13.0	18.0	16.0	13.0	9.0	10.8
20	10.0	10.0	6.0	9.0	18.0	8.0	11.0	8.0	7.0	15.0	13.0	13.0	16.0	15.0	20.0	24.0	15.0	7.0	7.0	5.0	11.0	14.0	15.0	10.0	12.0
21	8.0	8.0	8.0	5.0	5.0	3.0	3.0	3.0	5.0	5.0	5.0	5.0	5.0	6.0	6.0	6.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	4.9
22	6.0	11.0	12.0	13.0	13.0	13.0	14.0	16.0	17.0	16.0	16.0	15.0	11.0	9.0	9.0	9.0	8.0	9.0	8.0	9.0	9.0	9.0	13.0	14.0	11.6
23	12.0	13.0	16.0	17.0	15.0	14.0	16.0	15.0	12.0	15.0	12.0	11.0	10.0	11.0	15.0	13.0	15.0	11.0	9.0	7.0	8.0	6.0	6.0	5.0	11.8
24	6.0	4.0	6.0	7.0	8.0	6.0	6.0	11.0	12.0	12.0	13.0	8.0	4.0	6.0	9.0	13.0	11.0	9.0	5.0	5.0	3.0	4.0	3.0	6.0	7.4
25	6.0	7.0	11.0	11.0	10.0	10.0	11.0	9.0	11.0	14.0	18.0	17.0	17.0	16.0	14.0	14.0	14.0	11.0	9.0	9.0	6.0	10.0	6.0	2.0	11.0
26	6.0	7.0	3.0	4.0	4.0	7.0	14.0	15.0	14.0	10.0	9.0	15.0	14.0	11.0	8.0	9.0	6.0	9.0	6.0	3.0	3.0	2.0	3.0	5.0	7.8
27	6.0	8.0	7.0	4.0	7.0	8.0	10.0	8.0	5.0	12.0	15.0	15.0	19.0	8.0	12.0	12.0	10.0	11.0	8.0	8.0	6.0	11.0	3.0	3.0	9.0
28	4.0	3.0	5.0	3.0	2.0	4.0	4.0	6.0	10.0	7.0	4.0	4.0	6.0	6.0	5.0	10.0	18.0	20.0	17.0	15.0	16.0	14.0	11.0	9.0	8.5
29	7.0	4.0	5.0	3.0	3.0	2.0	4.0	2.0	3.0	6.0	5.0	5.0	6.0	9.0	9.0	8.0	11.0	8.0	7.0	4.0	5.0	3.0	4.0	6.0	5.4
30	1.0	2.0	4.0	3.0	2.0	1.0	4.0	3.0	3.0	4.0	5.0	6.0	9.0	6.0	9.0	9.0	5.0	5.0	5.0	10.0	8.0	6.0	4.0	3.0	4.9
31	6.0	9.0	9.0	7.0	5.0	4.0	4.0	6.0	8.0	4.0	6.0	7.0	9.0	12.0	12.0	12.0	13.0	10.0	6.0	5.0	3.0	1.0	2.0	3.0	6.8
AVG.	6.3	6.5	6.8	6.7	7.5	7.3	8.1	8.3	8.8	9.4	10.0	10.5	10.7	10.3	10.4	10.4	10.1	9.2	7.5	6.9	6.2	5.9	5.7	5.6	

# of Valid Hours = 744 % Data Completeness = 100.0

BISON ENGINEERING INC.
HELENA, MONTANA

MARCH 1992

*** *WIND DIRECTION SUMMARY* ***

HOURS

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVG.
1	258	244	251	264	242	236	230	241	236	230	212	206	201	204	201	208	290	283	152	193	202	53	19	49	224.0
2	4	29	101	207	57	193	211	215	213	207	198	196	202	217	218	206	211	211	216	215	215	247	41	7	213.6
3	21	46	29	47	63	28	3	16	25	76	219	284	83	59	63	54	55	60	45	20	47	260	193	207	56.1
4	223	227	46	57	55	16	217	238	236	232	219	221	255	271	293	301	263	257	263	197	337	331	341	335	42.1
5	184	161	351	238	209	43	33	72	93	106	195	36	43	42	59	74	105	98	102	99	10	93	191	211	66.0
6	218	292	191	42	340	40	24	38	48	177	24	5	28	54	169	205	202	209	212	215	298	30	241	214	57.8
7	228	58	232	244	254	166	236	179	75	65	181	207	193	227	337	351	4	39	77	63	33	64	39	36	29.1
8	7	357	7	10	7	38	64	66	70	80	85	75	62	59	61	51	40	45	43	49	29	39	40	201	29.2
9	261	204	251	238	228	239	252	53	60	64	64	273	274	269	272	296	4	357	66	230	244	244	243	242	8.6
10	244	235	234	230	232	230	245	238	217	220	242	258	267	276	270	269	262	242	287	267	229	224	69	25	261.8
11	168	63	213	240	241	238	239	237	221	225	222	260	273	267	268	268	308	335	299	198	213	243	206	217	270.2
12	234	240	241	236	233	232	230	223	218	215	213	220	275	270	257	313	345	12	213	207	208	228	207	213	288.7
13	183	211	231	218	236	241	235	234	132	43	33	41	47	42	90	64	60	66	31	321	263	218	217	210	312.8
14	208	315	127	340	20	360	20	11	62	65	45	72	97	82	97	186	190	197	310	3	344	334	35	360	315.5
15	2	356	25	194	217	226	216	328	201	203	217	205	208	219	243	185	212	224	19	159	343	208	252	334	144.2
16	85	261	215	316	214	226	213	222	241	220	266	288	38	63	285	213	100	68	61	62	59	44	49	60	114.7
17	65	60	56	74	70	65	70	77	72	67	48	81	84	228	216	13	269	264	215	101	14	25	221	8	70.9
18	10	2	6	7	17	24	49	61	45	50	43	58	43	45	52	67	81	53	351	11	200	187	220	212	48.5
19	227	239	237	239	238	231	221	227	216	205	200	198	208	231	222	237	239	239	250	224	226	220	240	246	234.9
20	245	237	237	238	260	250	218	254	252	244	244	256	268	305	350	341	333	314	197	78	61	68	84	69	275.6
21	56	32	27	14	9	198	159	99	88	86	84	343	33	45	88	44	42	54	24	346	157	183	240	234	50.9
22	213	242	236	236	232	225	216	206	203	203	205	203	202	206	216	240	248	252	213	209	229	223	218	219	215.9
23	206	199	200	202	204	205	203	207	201	197	204	212	231	287	274	268	247	250	213	221	221	235	223	79	209.1
24	51	360	331	343	76	16	2	54	65	58	57	50	53	47	74	64	62	60	42	344	217	216	310	211	49.4
25	188	222	235	236	237	242	233	242	223	229	254	256	256	255	257	267	271	272	250	211	234	229	226	44	242.5
26	207	213	119	86	36	189	214	213	226	209	224	203	208	202	201	193	149	92	50	340	105	56	56	24	175.8
27	18	341	275	250	212	216	210	223	226	228	284	284	260	205	212	239	250	222	238	239	231	254	265	232	249.5
28	39	60	311	190	40	122	349	358	352	293	297	327	86	57	96	67	73	73	79	80	72	65	54	52	61.1
29	32	8	358	17	357	210	202	226	61	58	47	38	62	57	61	70	76	58	51	6	352	186	202	220	52.9
30	342	346	5	13	349	183	158	28	33	87	33	215	194	226	43	131	19	73	74	78	70	13	314	275	69.2
31	24	70	52	33	331	355	22	51	68	88	59	56	52	53	57	63	73	51	48	11	73	4	271	6	51.1

\# of Valid Hours = 744 % Data Completeness = 100.0

BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon Livingston, Montana MARCH 1992

*** *WIND SIGMA SUMMARY (DEGREES)* ***

HOURS

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AVG.
1	13	23	25	12	12	13	14	10	16	26	15	12	13	12	15	23	22	49	69	10	17	37	32	53	23
2	21	35	63	58	67	44	12	12	11	13	14	13	16	13	12	13	12	11	11	17	55	46	46	63	28
3	24	39	32	31	39	63	25	20	22	53	25	66	30	28	19	17	15	10	35	30	30	72	27	16	32
4	11	11	74	81	52	24	56	11	10	17	18	55	66	71	41	55	17	9	9	77	37	13	8	26	35
5	42	26	32	27	24	45	65	14	28	49	63	52	31	28	27	43	27	15	34	77	38	54	19	18	37
6	39	51	14	59	10	27	30	34	72	56	43	16	38	49	27	34	20	13	12	24	55	57	25	23	35
7	28	42	42	38	22	76	20	74	13	20	44	23	17	66	17	14	17	36	11	28	30	13	27	27	31
8	13	18	14	11	12	16	9	10	9	10	10	10	9	10	12	16	11	11	10	10	13	13	18	44	13
9	23	13	16	19	10	14	48	21	12	14	66	12	12	13	13	41	13	11	54	54	45	13	10	9	23
10	11	11	14	14	14	17	12	13	11	13	22	12	12	11	12	11	12	15	58	87	78	64	35	70	26
11	73	48	44	10	9	10	9	13	13	15	16	17	11	11	12	11	43	24	86	31	28	42	46	54	28
12	14	14	10	10	14	13	11	12	11	12	11	19	10	15	17	53	30	21	51	22	11	37	56	27	21
13	68	67	23	25	15	8	8	11	51	19	15	20	26	34	38	18	13	10	31	17	70	23	21	33	28
14	29	58	60	72	34	42	19	30	29	24	30	32	40	37	57	30	18	13	78	53	44	56	50	15	40
15	17	18	26	81	55	34	64	39	65	24	15	12	17	29	60	36	40	43	64	83	62	57	84	78	46
16	69	65	26	88	35	18	17	33	17	20	16	42	31	37	82	30	56	13	11	10	10	12	13	11	32
17	10	11	13	10	11	11	10	10	10	14	23	54	51	47	67	74	17	11	59	71	28	62	47	29	31
18	41	9	10	12	19	24	24	15	10	12	14	14	14	19	16	18	12	28	10	43	21	24	24	19	19
19	17	9	11	9	10	13	13	15	13	9	12	16	26	25	24	15	15	10	22	13	13	15	20	20	15
20	19	16	24	20	20	24	14	31	34	10	12	16	13	30	12	9	16	32	33	36	10	15	10	11	19
21	20	10	12	17	15	50	13	35	15	22	39	46	45	42	38	35	39	17	21	23	82	14	24	36	30
22	23	10	10	11	12	10	17	12	13	12	12	12	14	16	20	22	14	10	12	6	14	20	11	10	13
23	14	11	11	10	11	12	10	12	14	12	14	17	34	18	13	21	15	14	26	17	44	46	51	57	21
24	31	64	46	73	21	40	26	24	13	11	12	36	63	42	27	12	13	10	18	11	64	19	75	50	33
25	84	66	9	9	13	8	8	12	13	17	13	13	15	13	15	16	14	10	14	11	41	18	29	71	22
26	66	60	64	43	34	45	14	9	12	16	21	11	15	21	26	31	42	12	30	38	87	60	44	36	35
27	38	35	26	61	40	20	17	21	36	28	13	11	11	41	24	20	16	14	16	31	17	28	59	70	29
28	47	54	27	62	85	47	66	28	10	35	60	76	66	42	62	17	10	9	10	12	10	13	12	13	36
29	21	15	14	26	73	24	11	29	57	33	39	55	34	23	20	23	11	14	14	25	21	49	14	18	28
30	62	25	13	44	22	66	63	29	35	33	31	46	36	66	40	52	57	19	22	17	16	68	68	58	41
31	38	15	17	30	18	21	32	22	15	43	33	28	20	15	16	13	12	18	17	23	56	36	66	85	29
AVG.	33	31	27	35	27	28	24	21	22	22	25	28	27	30	28	27	22	17	31	32	37	35	35	37	

BISON ENGINEERING INC.
HELENA, MONTANA

MARCH 1992

*** WIND FREQUENCY SUMMARY ***

DIR---> SPEED (MPH)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.0 - 4.0	2.8	3.1	3.2	2.2	2.0	0.7	0.1	0.8	1.3	2.3	2.0	0.9	1.1	0.8	0.5	1.9	25.8
4.0 - 7.5	1.6	2.8	4.0	3.0	1.3	0.1	0.0	0.5	0.8	3.5	4.3	1.2	0.3	0.5	0.5	1.5	26.1
7.5 - 12.1	1.3	0.5	3.2	4.4	0.3	0.0	0.3	0.0	0.1	3.6	5.8	6.2	1.1	0.7	0.3	0.3	28.1
12.1 - 19.0	0.0	0.0	0.5	2.8	0.5	0.0	0.0	0.0	0.0	5.2	4.3	2.7	3.0	0.3	0.1	0.1	19.6
19.0 - 24.7	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4
24.7 - 30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.0 - 40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.0 - 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVER 50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	5.9	6.5	11.0	12.5	4.2	0.8	0.4	1.3	2.3	14.7	16.4	11.0	5.4	2.3	1.5	3.9	
AVG. SPEED	5.6	4.5	6.6	8.9	6.1	3.7	6.7	4.1	4.5	9.9	9.3	10.0	11.9	7.1	6.1	5.6	

Calm Hours = 0.0%

Total Hours With Both Speed and Direction = 744

Average Wind Speed = 8.1 (MPH)

Resultant Windspeed = 2.0 (MPH)

Resultant Wind Direction = 234.3 Deg

Wind Persistance = 24.3 %

APPENDIX B

ENVIROCON INC.
Livingston, Montana

PM10 Calibrations - Wedding & Assoc.

Calibrated by : Dan McCaffery
Location : Livingston BN Site Downwind (Met)
Sampler # : 0240901114U
Date : 2/20/92

Calibration Orifice #S48-ECON: Q [m3/min] = .4998 [(dP)^.50378]
Last certified : 6/5/91

LOOK-UP:

Sampler Manometer = 18.9 inches water = delta
Barometric Press. = 25.5 inches mercury = P0
Temperature = 0 degrees celcius
= 273.2 degrees kelvin
P1/P0 = (P0 - [delta/13.6]) / P0
= 0.946

Q (look-up) [acfm] = {[T[k]/248]^0.5} * {[(P1/P0) * 84.5238] - 42.329}
= 39.09 [acfm] l-u

Q (look-up) [scfm] = acfm * (P0*298) / (29.92*T[k])
= 36.36 [scfm] l-u

REFERENCE TRANSFER ORIFICE STANDARD:

Orifice Manometer = 4.05 = dP
Qr [m3/min]r = .4998 [(dP)^.50378]
= 1.011 [cmm]r

Qr [cfm]r = Qr [cmm]r * 35.314
= 35.71 [cfm]r

Qr [scfm] = Qr [cfm]r * {(P0*298)/(29.92*T[k])}^0.5
= 34.44 [scfm]

Qr [acfm] = Qr [scfm] * {(T[k]*29.92)/(298*P0)}
= 37.05 [acfm]

Q [scfm] % Difference = {(Q [scfm]lu - Qr [scfm]) / Qr [scfm]} * 100
= 5.6 %

ENVIROCON INC.
Livingston, Montana

PM10 Calibrations - Wedding & Assoc.

```
Calibrated by  :     Dan McCaffery
Location       :     Livingston BN Site Upwind
Sampler #      :     0240901115U
Date           :     2/20/92

Calibration Orifice #S48-ECON:   Q [m3/min]       =.4998 [(dP)^.50378]
 Last Certified   : 6/5/91

LOOK-UP:
                     Sampler Manometer  =   18.75 inches water     = delta
                     Barometric Press.  =    25.5 inches mercury   = PO
                     Temperature        =       0 degrees celcius
                                        =   273.2 degrees kelvin
                     P1/PO              =   (PO - [delta/13.6])  / PO
                                        =   0.946

                     Q (look-up) [acfm] =  {[T[k]/248]^0.5} *
                                           {[(P1/PO) * 84.5238] - 42.329}
                                        =   39.49 [acfm] l-u

                     Q (look-up) [scfm] =  acfm * (PO*298) / (29.92*T[k])
                                        =   36.71 [scfm] l-u

REFERENCE TRANSFER ORIFICE STANDARD:

                     Orifice Manometer  =     4.1 = dP
                     Qr [m3/min]r       =   .4998 [(dP)^.50378]
                                        =   1.017 [cmm]r

                     Qr [cfm]r          =   Qr [cmm]r * 35.314
                                        =   35.93 [cfm]r

                     Qr [scfm]          =   Qr [cfm]r *
                                              {(PO*298)/(29.92*T[k])}^0.5
                                        =   34.64 [scfm]

                     Qr [acfm]          =  Qr [scfm] *
                                              {(T[k]*29.92)/(298*PO)}
                                        =   37.26 [acfm]

Q [scfm] % Difference        =        {(Q [scfm]lu - Qr [scfm]) /
                                                         Qr [scfm]} * 100
                             =        6.0 %
```

PM-10 Volumetric Flow Controller Audit

Site: BN Downwind (Met)

AIRS Number: 30- none

Audit Date: 4-2-92

Latest Calibration Date: 4-2-92

Audited By: E.T.Coenenberg

Calibrated By: Envirocon

Temperature (T_a) = 20.9°C

Barometric Pressure (P_a) = 25.4" Hg

Pressure Transducer Reading: N/A

Audit Orifice Number: E-34

Absolute Stagnation Pressure (from current calibration) P1 = .948

Look-up Table Flowrate (Qat) Using T_a and P1 = 1.154 m^3/min

Audit Orifice Pressure Drop = 2.7" H_2O

VFC Orifice S/N: Wedding 0240901114U

Audit Orifice Flowrate (Qao) @ T_a & P_a = 1.088 m^3/min

Audit Flowrate % Difference $\left(\frac{Qat - Qao}{Qao}\right) \times 100$ = +6.1% ((± 7%)

Corrected Sampler Flowrate $\left(\frac{Qat \times (100 - \text{Audit \% Diff.})}{100}\right)$, Qac = 1.084 m^3/min

Design Flowrate % Difference = $\left(\frac{Qac - 1.13}{1.13}\right) \times 100$ = -4.1% ((± 7%)

Comments:

PM-10 Volumetric Flow Controller Audit

Site: BN Upwind

AIRS Number: 30- none

Audit Date: 4-2-92

Latest Calibration Date: 4-2-92

Audited By: E.T.Coenenberg

Calibrated By: Envirocon

Temperature (T_a) = 21.8°C

Barometric Pressure (P_a) = 25.35" Hg

Pressure Transducer Reading: N/A

Audit Orifice Number: E-34

Absolute Stagnation Pressure (from current calibration) P1 = .951

Look-up Table Flowrate (Qat) Using T_a and P1 = 1.176 m^3/min

Audit Orifice Pressure Drop = 2.8" H_2O

VFC Orifice S/N: Wedding 0240901115U

Audit Orifice Flowrate (Qao) @ T_a & P_a = 1.110 m^3/min

Audit Flowrate % Difference $\left(\frac{Qat - Qao}{Qao}\right) \times 100$ = +5.9% ((± 7%)

Corrected Sampler Flowrate $\left(\frac{Qat \times (100 - Audit\ \%\ Diff.)}{100}\right)$, Qac = 1.107 m^3/min

Design Flowrate % Difference = $\left(\frac{Qac - 1.13}{1.13}\right) \times 100$ = -2.0% ((± 7%)

Comments:

METEOROLOGICAL MONITORING SYSTEM
Climatronics EWS Audit

Performed by C. Loomis

Location Envirocon, Livingston Railyard

Date 2-19-92

Serial No.

FIELD USE

East/West Theodolite Position	North/South Theodolite Position
Vertical Alignment of Wind Speed: ok	Vertical Alignment of Wind Speed: NA
Vertical Alignment of Wind Direction: ok	Vertical Alignment of Wind Direction: NA
Cross Arm East/West: NA	Cross Arm Horizontal: -
	Indicated North: 360 degrees

Temperature Check

NIST (NBS) Temperature: 7.8 oF

DAS Temperature: 7.8 oF

Strip Chart Temp: oF

Wind Vane (Direction Comparison)			Wind Speed		
Approx. Direction	DAS	Strip Chart	Motor Speed	DAS	Strip Chart
0/360	360	---	0	1	---
90			(Sync. Motor) 18.2	18.6	---
180	180	---	(Sync. Motor) 9.1	9.8	---
270					

Linearity Check

	0	30	60	90	120	150	180	210	240	270	300	330
DAS												

NOTES Due to severe weather conditions wind vane settings were non-attainable and north-south theodolite postions were non-attainable.

Rev. 2/92